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Some researches as to Lime and Mortars. By M. Courtois, *Engineer of Roads and Bridges.** (*From the Annales des Ponts et Chaussées, Paris,* 1834.) *Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

(Continued from page 321.)

The art of making good mortars is every day becoming better appreciated, from the influence it exercises in the economy and on the duration of constructions. If, in every great work, the constructors would make known the researches they have instituted, and the conclusions to which they have been led, we should soon know the resources presented by each locality, and be every where able, progressively, to improve the manufacture of mortars.

Having had occasion at various times to make numerous essays on lime and hydraulic mortars, and on the means of making them economically, I think I am fulfilling a duty in presenting a summary of the principal results.

My investigations have had particularly in view the qualities of the mixtures, or combinations of lime and clay, comprised between hydraulic lime and cement; but in order not to leave any void in the scale of various proportions to be tried, I thought it best to try all combinations possible with 100 parts of the mixture.

I shall examine successively,

1st. The elements of these combinations, viz. limestones, clayey earth, and marl; I shall give the analysis of each, and examine their respective properties.

2nd. The combinations made with the most simple proportions, and which, for greater clearness in the tables, I shall call combinations of the first order: these will be mixtures of 1, 2, 3, 4, &c., parts of clay, with 9, 8, 7, 6, &c., parts of lime.

3rd. The combinations of the second order, or hydraulic pastes, result-

*The object of these researches was to give to fat lime the hydraulic quality necessary, and to mortars a determinate resistance, at a small expense.

ing from the preceding compounds, mixed, in their turn, with various proportions of fat lime.

4th. Combinations of the third order, or mortars resulting from the mixture of the preceding hydraulic pastes with twice their volume of sand.

I shall give, moreover, the experiments made with each hydraulic paste, and each mortar, to determine the hardness, after various periods of immersion, and to determine at the same time the resistance to rupture of each of the combinations.

I shall afterward examine the natural substances analogous to these several artificial combinations: indicating how they may be known, and showing the abundance of these hydraulic substances in nature.

Following my observations on the resistance of artificial hydraulic pastes, I shall give analogous experiments applied to the comparison of a great number of natural hydraulic pastes, and mortars made of these pastes.

Article xx.—*Artificial combinations of Lime and Clay.*

Lime. Without going into details as to the chemical properties of lime, it may suffice to say that this substance forms the base of limestones, and gypsum, or plaster of Paris; and that it combines, at a high temperature, with silex, forming what is called a silicate of lime. In the humid way, it appears to combine with clay, either crude or calcined, affording a hydrosilicate with a base of lime and alumine.

Lime, as it is used in making mortars, is obtained by the calcination of limestones, which are carbonates or subcarbonates more or less pure, found in all the formations; it is obtained also from some animal productions, as shells of oysters, and other shells.

The effect of calcination is to drive out the water and carbonic acid. By breaking the stone into pieces about one and a half inch square and passing a current of steam through the ignited mass, a cubic metre (35.32 cubic feet) of lime stone may be converted into lime, in a kiln with a continual fire, by burning about seven cubic feet of sea-coal:* in cold and moist seasons the consumption of coal is augmented; and amounts, sometimes, to a third of the volume of the stone.

If the limestone be argillaceous, the fire should be managed cautiously, and be less violent than to calcine a nearly pure carbonate of lime; for when the fire is too high, the lime and clay fuse, and give a vitreous matter inert, or without causticity, which is a double silicate of lime and alumine.

Whenever a piece of limestone is cooled before the calcination is completed, it becomes necessary to wet it before putting it again in the kiln; without this precaution, it would be very difficult to reduce it completely to lime.

After calcination, lime has a great affinity for water, and augments in volume, by absorbing it. If a certain quantity of water be thrown on lime

* On the canal of Ardennes, where I caused large quantities of lime to be burned, the lime burners threw into the kiln one measure of sea-coal to five, six and even seven measures of limestone; it should be observed, however, that the stone was a chlorite-chalk, easier to convert into lime than limestones generally.

At Theil in the department of Ardèche, whence the best hydraulic lime that I know of is derived, they consume but one sixth of a measure of sea-coal in burning one measure of lime. Author.

recently calcined, it heats, splits open, and is reduced to powder, or paste, according to the quantity of water absorbed; during this operation, a little water is carried off by the heat; but, when the lime is obtained from a nearly pure limestone, the volume of paste after slaking, is, sensibly, equal to the volume of water absorbed.*

Clay. Clays are composed of silex and alumine in variable proportions, often mixed with quartzose sand, oxide of iron, magnesia and lime. When the clays contain no sand, they are fine and soft to the touch; and form with water an unctuous paste susceptible of being moulded into any form.

The clays which I chiefly used are those of which the analyses are given in columns 1, 2, 3, and 4, of table LVII.

Combinations of Lime and Clay. If crude clay be mixed with various proportions of lime, pastes are formed which have much more consistence than clay alone: this paste, put under water, acquires at the end of three days, a certain hardness which it preserves, afterward, indefinitely; it attains its maximum of resistance, when one part of lime is mixed with nine parts of clay; this paste, after three days, resists the pressure of the thumb.

When a mixture of lime and clay, exposed for some days to the air, has lost a part of its water, without having been dried too rapidly, it may be afterward immersed without sustaining any alteration, provided the volume of lime be not greater than one third that of the clay; the proportion of lime might be less but should not be greater. A mortar of this sort might be used in the construction of cisterns, reservoirs, and other works, where an insoluble, rather than a strong, mortar is needed. I regret not being able to state the actual resistance of mortars made of lime and crude clay, but at the period I was occupied with these first researches, the har dening under water was the property to which I confined my attention.

The quality of augmenting the resistance of lime, which crude clay possesses appears to have been known for a long time in *Champagne*, where all the wooden houses are covered, exteriorly, with a plaster composed of lime and a white argillaceous and calcareous earth. The floors are also made with a plaster of the same nature, and when not dried too rapidly, they resist perfectly.

This property explains how it is that sand, mixed with a certain quantity of crude clay, forms a mortar with lime, which acquires a degree of hardness under water that does not, however, increase after some days.†

If fat lime, and clay containing little or no calcareous matter, be mixed, 1, 2, 3, 4, 5, 6, 7, 8 and 9, parts of clay, respectively, with 9, 8, 7, 6, 5, 4, 3, 2 and 1 parts of lime, a series of eleven compounds will be formed, of which the first term will be pure lime, and the last, pure clay; if the last ten compounds be calcined, substances will result possessing the properties about to be described.

*In a considerable number of experiments that I had occasion to make in 1823, I always obtained the above relation between the bulk of the slaked lime, and the absorbed water; the quantities of lime on which I experimented, varied from three and a half to ten and a half cubic feet. Au.

†The sands now referred to must not be confounded with those which contain, in their interstices, mud or slime more or less charged with animal or vegetable matter; when this last kind of sand is used, the lime forms, with the animal or vegetable substance, a soap, more or less soluble, which opposes the hardening of the mortars. Sands of this kind, if not washed free from these matters before they are used, always give very bad results.
Author.

Hydraulic lime. The first two mixtures will give hydraulic lime, as Mr. Vicat has long since made known.

The lime of the first compound is moderately hydraulic, hardens slowly in water, and takes, in time, the consistence of hard soap.

The lime of the second, acquires, after three days immersion, the hardness of chalk: after 20 days immersion, it permits a stem 0.08 inch in diameter, loaded with 2.20 lbs. falling from a height of two inches, to penetrate 0.12 inch: and after two months immersion, it shows no sensible impression from the shock of the stem.

On mixing the lime of the first two compounds with fat lime, they divide with this last their hydraulic properties; but these properties decrease quite rapidly. Hydraulic lime containing 0.20 of clay, mixed with an equal volume of fat lime, acquires at the end of two months the hardness of lime containing 0.10 of clay. By this kind of mixture, the energy of lime, slightly hydraulic, is sensibly augmented; a lime which would take only a feeble consistence when alone in water, acquired, by mixture with one quarter, or only one fifth, of very hydraulic lime, the properties of limes that are moderately hydraulic.

Lime-cement. The four following compounds, containing 3, 4, 5, and 6 parts of clay united with 7, 6, 5, and 4 parts of lime, give, by calcination, substances that slake slowly, disengaging but little heat; but when pulverized and made into paste, increase in volume, and acquire, promptly, great hardness under water. Their augmentation of volume continues some time after they have commenced hardening; for if a glass be filled therewith, it splits in all directions, but the cracks do not become apparent till a month or two after it has acquired a hardness equal to that of chalk. This augmentation of volume, which breaks the glass in which the experiment is made, is however but slight; for when the paste is made into the form of bricks, it is rare that it presents fissures. Each of these compounds mixed with an equal volume of sand, and even with a double volume, gives a hydraulic mortar which, after six hours immersion, resists the pressure of the thumb: and after eight days, perfectly resists the shock of the stem above spoken of.

Besides the properties mentioned, the same compounds communicate to fat lime their hydraulic qualities; imparting all the energy of lime eminently hydraulic.

If 1, 2, 3, 4, 5, 6, 7, 8 and 9 parts of the powder of each of these compounds be taken, and mixed respectively with 9, 8, 7, 6, 5, 4, 3, 2 and 1 parts of fat lime, different degrees of hydraulic property will be given to the latter: with five parts of powder, a lime eminently hydraulic will be obtained: two parts of powder will suffice to make eight parts of lime hydraulic; but, one part of powder will communicate only a feeble degree of hydraulic property to nine parts of lime; after eight days' immersion, this last mixture will hardly have the consistence of moist soap.

If, an hour after the mixture, all the pastes made of the lime and powder, above mentioned, be immersed, they will set under water in six days for the least hydraulic; after that time, the hardest will resist the pressure of the thumb. Each of these pastes mixed with a volume of sand equal to the volume of paste at least, and to twice the volume of paste at most, will give a mortar which will harden in water a little less rapidly than the paste without the sand.

The compound of five parts of lime and five parts of clay is that which gives the most energetic powder.

According to the proportions of lime and powder, the paste is more or less gritty or more or less unctuous, but all harden in a short time after immersion: for example the powder derived from the compound of four parts of lime and six parts of clay gave results sensibly the same as those derived from a compound of six parts of lime and four parts of clay.

The compounds of which we have been speaking enjoy, therefore, the properties of lime and cement, at the same time. When mixed, alone, with sand, they serve to make mortars—acting, in this respect, like lime; when, on the other hand, they give hydraulic properties to lime, they, in that respect, act like cement: this double property has induced me to designate them by the term *lime-cement*.

Hydraulic Cement.—The terms of the series composed of 7, 8, and 9 parts of clay, respectively mixed with 3, 2 and 1 parts of lime, give, by calcination, substances that do not slake: their colour is more or less reddish, according to the greater or less quantity of oxide of iron in the clay. These matters being pulverized and made into paste, form a mortar, more or less meagre, which hardens under water in the space of ten days.

The powders of these compounds, mixed with various proportions of fat lime, give hydraulic pastes which harden under water in a few days.

These compounds being true cements, enjoying the property of hardening when alone under water, it seems convenient to designate them as *hydraulic cements* in order to distinguish them from *common cement* which, when alone, will take no consistence under water.

Common cement.—Clay, as has been long known, gives, by calcination and pulverization, a cement that being mixed with fat lime in various proportions, forms a mortar that hardens slowly under water, but which in time acquires a degree of hardness superior to that of hydraulic lime, either alone or mixed with sand, as we shall have occasion to show when on the subject of resistance to rupture of hydraulic paste and mortar.

Mode of mixing.—All the mixtures or combinations spoken of were made at the moment of slaking the lime*, or a short time afterwards.

When lime has been slaked for several days, the pastes and mortars split under water, take but little consistence, and seem to abandon their lime; which does not occur, or is much less sensible, when lime newly slaked is used: I content myself with stating the fact, without pretending to explain it.

When the lime is immersed while hot, an analogous effect is observed; but then it is caused by the swelling of a paste not saturated with water before the immersion.

The mixtures should, therefore, be made at the moment of slaking, but they should not be immersed for three or four hours afterward, if the volume is small, nor for twenty or thirty hours afterward when the bulk is considerable.

Mode of experimenting.—In the first experiments I had occasion to make, I mixed fat lime with a brick earth of which the analysis is given in the first column of table LVII.; this earth containing hardly $\frac{1}{10}$ of calcareous matter gave combinations possessing all the properties described above.

At this first period of the experiments—then less methodical than after-

* The slaking was always done by the ordinary process, that is to say by adding to the lime in a basin, the necessary quantity of water.—*Author.*

ward, I contented myself with putting into the glasses, volumes of paste occupying about a third of their capacity, and then pouring on water to fill the vessel. I subsequently measured the degree of advancement of the induration, by letting fall, from a height of two inches, a stem of iron $\frac{8}{100}$ of an inch in diameter, and loaded to weigh 2,2 lbs.

In a second series of experiments, I made use of argillaceous earth of which the analysis is given in the second column of the table LVII: this earth, as the analysis shows, contains nine per cent. of lime: it therefore gave pastes less resisting, and of a less prompt induration, than the preceding.

The volumes of paste were equal. To this end they were moulded in a hollow tin prism 1.8 inch long and 1.2 inch square: the substance thus moulded was, while still soft, forced out of the tin prism by a piece of wood of the same form and size, and placed at the bottom of a glass; each prism thus deposited at the bottom of a glass, remained half an hour exposed to the air and was then covered with water.

In mixing successively 9, 8, 7, 6, 5, 4, 3, 2, and 1 parts of the powder of the *ten combinations of the first order* with 1, 2, 3, 4, 5, 6, 7, 8, and 9 parts of fat lime, I obtained 100 combinations of the second order, or, in other words, one hundred different hydraulic pastes.

The figures of the two horizontal lines at the top of tables LIX. and LX. indicate the respective numbers, first, of the parts of the substances *a*, contained in the second column as combinations of the first order; second, of the parts of fat lime, which were mixed therewith to form the combinations of he second order.

The pastes of the same vertical column are, consequently, composed of the same number of parts of fat lime mixed successively with a certain number of parts of the several matters *a*, or combinations of the first order, mentioned in the second column of the table.

Hardening of Hydraulic Pastes.—To measure the degree of advancement of the induration of the several hydraulic pastes, I could not use the stem loaded with 2.2 lbs. of lead, because it would certainly have broken the prisms: I replaced it by another $\frac{48}{1000}$ of an inch in diameter, loaded with lead so as to weigh $\frac{3}{4}$ of a pound.

Fifteen days after the immersion, each prism, withdrawn from the water in which it had been immersed, was submitted to the shock of the stem just described, falling from the height of $\frac{8}{10}$ of an inch only; the number inscribed in each column of the table LIX, indicates the penetration for each prism.

Several prisms perfectly resisted the shock, and sustained no sensible penetration: others presented irregularities in their resistance without any apparent cause.

Two months after the immersion, the prisms were submitted to a second proof; the stem falling, then, from a height of $1\frac{6}{10}$ inch; the numbers expressive of the degree of penetration of the stem into each prism, are given in table LX.; as the effect of the shock should be double in the second proof what it was in the first, and as the degree of penetration had generally diminished, it results that in the space of forty days the resistance of all the hydraulic pastes was more than doubled.

After four months immersion, the stem, let fall from a height of $2\frac{4}{10}$ inches—the greatest height the instrument would allow, produced no sensible effect on the greater part of the prisms.

Resistance to rupture of hydraulic pastes.—At this period I thought it proper to measure the resistance to rupture. To obtain this resistance, I

operated with each hydraulic paste, on a prism 1.80 inch long, and 1.20 inch square, making use of an arrangement similar to that described by General Treussart in his work on mortars. Each prism passed through a small iron stirrup, and rested on two supports which were 1.20 inch apart; from the stirrup was suspended a scale-pan on which was placed, successively, greater and greater weights: that which caused the rupture was noted, and augmented by the weight of the stirrup and scale-pan, which was 12.10 lbs. The numbers indicating the weights that broke the prisms, are inserted in table LXI.

The results comprised in table LXI. present some anomalies, of which several were caused by voids that were found in a number of the prisms: others supported greater weights than was to be expected from their composition, without my being able to assign the cause.

The same table shows that lime moderately hydraulic, containing 0.10 of clay and 0.90 of lime, mixed in different proportions with fat lime, afforded prisms which supported from 29.0 lbs. to 66 lbs.

It also shows that very hydraulic lime, containing 0.20 of clay and 0.80 of lime, in the same circumstances, gave prisms that supported from 53 lbs. to 207 lbs.

That prisms of lime-cement mixed with different proportions of fat lime, supported from 53 lbs. to 440 lbs.

That prisms of hydraulic cement and fat lime, supported from 44 lbs. to 363 lbs.

That prisms of common cement and fat lime, sustained from 0.00 to 356 pounds.

A prism of common burnt brick, such as is used at *Rive-de-Gier*, having exactly the dimensions of the prisms of hydraulic paste, broke under a weight of 117 lbs.

Of the 100 prisms tried, 69 had strength superior to this well burned, but coarse grained, brick.

Resistance of mortars to rupture.—At the same time that the prisms of hydraulic paste were moulded, the same pastes were mixed with double the volume of sand, forming one hundred hydraulic compounds inserted in tables LIX, LX, and LXI. Combinations were thus formed of a third order, which we call mortars; these were moulded into prisms 4 inches in length by $1\frac{8}{10}$ inch square.

After four months immersion, the resistance to rupture of these mortar prisms was determined. To this end each prism was passed through a stirrup and made to rest on supports that were two inches apart: to the stirrup was appended a scale-pan in which weights were placed to cause the rupture: the weight which effected the rupture, increased by that of the scale-pan and stirrup, which was $12\frac{1}{10}$ lbs., was noted. The weights thus determined are inserted in table LXII.

These numbers are much weaker than might be expected from the resistances afforded by the hydraulic pastes (table LXI:) which deficiency in the resistances of these mortars, appears to be due to the quantity of sand, which was generally too great: in fact, *lime cements, and cements*, contain within themselves a certain quantity of matter not susceptible of slaking, and which, consequently, acts as sand: the portions of true hydraulic paste which should serve to bind together the sandy particles, were therefore in too small quantity in the greater number of the prisms.

I wished to leave the mortars immersed during at least one year, but time failed me.

A prism of common burnt brick, having exactly the dimensions of the prisms of mortar, broke under the weight of 240 lbs.

Of the 100 mortar prisms submitted to trial, there were but 5 that were superior to the brick prism.*

From what precedes, results the following classification of combinations, elementary in some sort, which may enter into the composition of mortar.†

1st. *Fat lime*—which does not contain clay, or in which the clay is less than the $\frac{1}{10}$.

2nd. *Hydraulic lime*—which contains that of $\frac{1}{5}$ of clay.

3rd. *Lime cement*—which contains from $\frac{1}{5}$ to $\frac{3}{5}$ of clay.

4th. *Hydraulic cement*—which contains from $\frac{2}{5}$ to $\frac{1}{10}$ of lime.

5th. *Common cement*—in which the lime is wanting, or exists in quantity less than $\frac{1}{10}$.

ARTICLE XXI.—*Natural Combinations of Lime and Clay.*

Limestones capable of affording hydraulic lime.—Lime, silex and alumine, the elements necessary to hydraulic lime, are substances that Nature affords in abundance in the secondary and tertiary formations: the crust of the globe is almost entirely formed of them: each of these substances alone, forms layers more or less thick, which often alternate with the others: this alternation is to be seen whenever, in the same formation, there is a change in the nature of the rock: thus, as is frequently seen, strata of clay, alternate with calcareous layers, and with strata of sand stone or free stone. When this happens it is rare that the stratum is entirely composed of the one substance; in the passage of the calcareous strata, for example, there are formed, first, calcareous strata containing a small quantity of clay, then, becoming more argillaceous, passing often to the state of marle, and at last, the clay is found almost alone, or without mixture of lime. When a succession of this nature is presented, it may be conceived not to be difficult to find a calcareous layer wherein the clay will exist in proportions suitable for hydraulic lime.

The preceding observation has often been useful to me in directing my search for natural hydraulic limes. In the Jura limestone formation (*formation Jurassique*,) for example, where such alternations are frequent, I have found hydraulic lime: 1st. near *Brabant* (Meuse,) in the oolitic beds which alternate with beds of clay: 2nd. near *Villers-le-Tourneur* (Ardennes,) in other oolitic layers, presenting the same alternations: 3rd. near Joinville (Haute-Maine.)

For a long time, a bed of gryphite lias, alternating with beds of clay, and which gives a lime slightly hydraulic, has been quarried near Lyons.

Near Macon, there exists a quarry of the same kind in the oolitic layers; the lime of Sury (Loire,) and that of Theil (Ardèche,) which are very hydraulic, are derived from some layers of lias found under analogous circumstances.

In the inferior layers of the chalk formation, where the same alternations are remarked, I very easily found hydraulic limes at different points on

* When on the subject of natural *lime-cements* and of *common cements*, I shall refer to mortars that supported, after four months, a load almost twice as great as the greatest inserted in the table.—*Author.*

† In almost all localities, Nature offers the materials proper to form the different elements of mortar, in abundance; as will be shown in the following article.—*Author.*

the limits of the formation, as Saint-Menehould, Rethel, and Vitry-le-Français.

In the tertiary formation, having noticed alternations of lime and clay near Hermonville (Maine,) near Valsery (Aisne) in the calcareous beds containing cerithiœ, and lastly, near Chateau-Thierry, in the strata of siliceous limestones, it was easy to point out the layers which it was proper to try, in searching for hydraulic lime.

The preceding observation is always true for the beds of the same formation; but it ceases to be exact at the point of passage of different formations. The chalk formation, for example, is often covered with the plastic clay which belongs to the tertiary: but these two layers appertain to two distinct formations; the first had existed for a long time before it was covered by the second; the calcareous matters not having been produced simultaneously, the two substances are simply juxtaposited, without alternation or mixture.

We may conclude, from what precedes, that whenever limestone is found alternating with clays or marls, one or several of the layers will give hydraulic lime. Five or six trials with small specimens will suffice to show which of the layers should be quarried.

I will terminate what relates to natural hydraulic limes by stating the process to which I submitted some of the limes, and the mortars into the composition of which they entered.

The experiments on the natural hydraulic pastes, and on the mortars made from them, were conducted under the same circumstances as the experiments mentioned in tables LXI and LXII, with the artificial combinations.

The prisms of hydraulic paste were $1\frac{8}{10}$ inch long and $1\frac{2}{10}$ inch square, and were placed on two supports which were $1\frac{3}{10}$ inch apart.

The prisms of mortar were four inches long and $1\frac{8}{10}$ inch square, and were placed on supports which were two inches apart.*

The same stirrup rested on the prism, and had suspended from it the scale pan, weighing, together with the stirrup, $12\frac{1}{10}$ lbs.

The lime derived from Theil (Ardèche) is the most powerfully hydraulic of any I have met with: it is obtained by burning a limestone of which the analysis will be found in the fourth column of table LVII.

A prism of this lime having exactly the same dimensions as those of the hydraulic pastes in table LXI, broke under a weight of 229lbs; its resistance, after four months immersion, was, consequently, double that of a brick of the same dimensions.

*Knowing the resistance E of a prism of matter having the dimensions of those of the hydraulic paste, it is easy to determine the resistance E′ of a prism of the same substance having the dimensions of the prisms of mortar; by using the formula $E=R\frac{ab^2}{c}$ in which a is the breadth of the prism, b its depth, and c the distance between the supports.

For other dimensions we have $E'=E\frac{\frac{a'(b'^2)}{c'}}{\frac{a(b^2)}{c}}$

And in substituting for a, b, c and a', b', c' the above values, we find

$E'=2.025\ E.$ AUTHOR.

In table LXIV, I have given the results of the proofs to which I submitted different prisms of mortars composed of Theil lime mixed with different quantities of sand: these mortars after one month broke under a weight varying from 59lbs. to 81lbs. Mortar composed of one part of lime and four parts of sand, broke under a weight of 59lbs., and that composed of one part of lime and one and a half part of sand, broke under a weight of 81lbs.

A prism of mortar composed of one part of Theil lime and two parts of sand, after four months immersion, broke under the weight of 469lbs.; the resistance of the mortar was, consequently, six times that of the same mortar one month old, and twice that of a brick.

In the environs of *Rine de Geir*, are the remains of a Roman aqueduct which conveyed a part of the waters of the Saint Etienne to Lyons; I extracted from these ruins a piece of mortar which appeared to be as hard as stone, and cut it carefully to the same dimensions as the prisms that had been tried: the prism of this mortar sustained a weight of 519lbs., only 50lbs. more than was borne by the prism made of Theil lime.

A prism of mortar composed of one part of lime from Vitry le Français, and two parts of sand, sustained, after four months immersion, a weight of 145lbs.

The lime from Sury (Loire,) which is generally regarded as very hydraulic, mixed with double its volume of sand, gave a prism of mortar which, after four months' immersion, broke under the weight of 64lbs. The resistance of this mortar was therefore hardly equal to the seventh of that of the mortar made of Theil lime. The small resistance of the mortar made of Sury lime, the hydraulic quality of which has been long known, resulted doubtless from some defect in the prism—perhaps an imperceptible crack.

Calcareous Stones and Earths which afford Lime-cements.

Every locality does not present the alternation of limestone and clay which facilitates the research for natural hydraulic limes; and it often happens that there is but one rock, and that, nearly homogeneous. Towards the middle of the chalk formation between Chalons and Troyes, the chalk is an almost pure calcareous carbonate, in which we seek in vain for a layer sufficiently argillaceous to afford hydraulic lime. The calcareous rocks, so abundant in the tertiary and secondary, are almost entirely wanting, or are only rarely found, in the lower formations. In these formations, there is no room for choice; it is necessary to use such limestone as can be found, and these rarely contain the proportion of clay that will yield hydraulic lime; but it is not rare to find, in these localities, substances which will give, by a moderate calcination, the *lime cements*. The greater part of the marls are of this sort, the clay and the lime composing them existing in variable proportions comprised within the limits affording *lime cements*: these substances are very common in France, and it will be as economical as advantageous, to give to fat lime the required degree of hydraulic property by mixing therewith marls calcined and pulverized.

When we are at liberty to choose, the marls that contain little or no sand should be preferred, so that the hydraulic paste which they assist in forming may bear the greater proportion of sand, and give a greater volume of mortar.

The calcination of marls requires a degree of heat less than that necessary

to the calcination of limestone: when the fire is too great they vitrify, and form a double silicate with base of lime and alumine; when the fire is less ardent, they give a compact substance of which the fracture is slightly vitreous; this matter is difficult to pulverize, and gives a nearly inert cement; when the degree of heat is just sufficient, the fracture is dull, and the substance is generally easy to pulverise. Such wheels as are used in extensive works, for making mortar, will suffice to this end. When the degree of heat is insufficient, the cement is mixed with earthy portions which impair its energy.

It is difficult to give a general rule for the calcination of marls, because some require a degree of heat quite elevated. To ascertain, by an easy experiment, the degree of heat that each kind requires, the portion may be moulded into the form of a cylinder $4\frac{8}{10}$ inch in length by $1\frac{2}{10}$ inch in diameter, and exposed, one end in a violent fire, and the other on, or near, the outside of the fire; when the most highly heated end has begun to vitrify, the cylinder may be withdrawn from the fire and divided into four parts according to the apparent effects of the different degrees of calcination: by pulverizing each, it is easy to determine the degree of calcination which gives the most energetic cements: to prevent the cylinder breaking in the fire it is necessary to mould it around a wire.

It is requisite that the burned marl be pulverized, before the mixture with the lime; otherwise, the marl will absorb water, which will impair the energy of the powder, and prevent its intimate combination with the lime.

I had occasion to try several marls from the Departments of Loire, Ardennes, Maine and Rhone; they all gave good results. Parker's cement (English,) the Boulogne pebbles, and the Saint-Leger cement, are derived from marly stones which contain about as much clay as lime.

The Senonches lime comes from a marl containing more lime than clay: all these substances are, consequently, so many lime cements.

I made numerous experiments with three kinds of marl the analyses of which are inserted in table LXVII, columns Nos. 6, 7 and 8.

The first comes from Saint-Just, department of Loire, the second from Aubigny in the same department, and the third from the Rhone at Lyons and at Givors.

The marl of Saint-Just contains only 36 parts of lime united with 41 parts of clay; this marl, calcined and pulverized, gives a very energetic lime cement.

The 5th and 6th experiments of table LXIII, prove that 8 and 7 parts of powdered marl united with 2 and 3 parts of lime, gave a hydraulic paste which, hardly two months old, sustained the weight of 361 and 312lbs.

The experiments 27, 28, and 29 of table LXIV, show that mortars four months old, composed of a hydraulic paste, half of which was made up of powdered marl from Saint-Just, mixed with twice its volume of sand, broke under the weight of 92lbs. The want of resistance in these mortars arises from the excess of sand. The Aubigny marl contains only twenty-five parts of lime to fifty-five parts of clay: this marl, calcined and pulverized, affords a lime-cement of moderate energy.

Experiments Nos. 11, 12, 13 and 14 of table LXIII show:

1st. That a prism of the powder, after four months immersion, broke under the weight of 154lbs.

2nd. That a prism of 9 parts of this powder, mixed with one part of fat lime broke under the weight of 141lbs.

3rd. That prisms of 8 and 7 parts of the powder, mixed with 2 and 3 parts of fat lime supported only 66 and 44lbs respectively.

The resistances of the prisms of mortar composed of powdered Aubigny marl, fat lime and sand, present much fewer irregularities than the prisms of paste.

Experiment No. 31 of table LXIV, shows that a prism of mortar made of one part of the powder and two parts of sand, immersed for four months, broke under a weight of 35lbs.; while experiment No. 34 proves that a prism of mortar composed of 4 parts of fat lime united to 6 parts of the powdered marl and 20 parts of sand, did not break till the load amounted to 174lbs.

The slight resistance of prism No. 31 results, evidently, from the excess of sand mixed with a powder whereof more than half already performed the office of sand, so that the prism contained hardly $\frac{1}{3}$ of powder susceptible of conversion into lime.

The Givors marl contains only 24 parts of lime united with 55 parts of clay, but, after burning, it is easier to pulverise than the marl of Aubigny. and gives a more energetic powder.

Experiment No. 3 of table LXIII, shows that a prism of this powder made into paste, after two months immersion, supported 222lbs.

Experiment No. 4 shows that another prism, of which the paste was composed of 4 parts of fat lime united to 6 parts of the powder, broke with the weight of 165lbs.

Experiment No. 26 of table LXIV. shows that a prism of mortar, one month old, composed of 1 part of powdered marl and three parts of sand, broke with the load of 37lbs.

Experiment No. 13 shows that a mortar composed of 1 part of the marl in powder and 2 parts of sand, broke under the weight of 51lbs., while experiment No. 23 shows that a mortar composed of two parts of powdered marl and 1 part of sand, sustained the load of 224lbs. Sand mixed with pastes made of powdered marl reduces their resistance, therefore, very much: this effect is less sensible with hydraulic pastes composed of fat lime and powdered marl, as seems to be proved by experiments No. 14, 15, 16, 17, 18, 19, 20, 21 and 22.

According to experiment No 22 of table LXIV, a mortar composed of 1 part of fat lime, 1 part of powdered marl and 2.40 of sand, broke with the load of 134lbs.

According to experiment No. 20, a mortar composed of 1 part of fat lime, 1 part of powdered marl, and 2.50 of sand, broke with the load of 136lbs.

And according to experiment No. 18, a mortar composed of 1 part of lime, 1 part of powdered marl, and 1.60 of sand, broke with the load of 139lbs.

These mortars being hardly a month old, the trials do not show sufficiently the influence of lime: I wished that more time should elapse, but being called away by particular circumstances, I preferred shortening the period to leaving out these trials.

Earths which will afford Hydraulic Cements.

The substances that I have designated *hydraulic cements*, and which are composed of 7, 8, and 9 parts of clay, respectively mixed with 3, 2 and 1 parts of lime, are true artificial puzzolanas; for analysis has shown that na-

tural puzzolanas contain about $\frac{1}{11}$ of lime combined with silex and alumine. The greater part of argillaceous earths, and marls, effervescing with acids, and containing less than 40 per cent. of lime, may, when they do not contain too much sand, give by calcination and pulverization, natural hydraulic cements, susceptible of hardening under water. Each of these cements without any addition of lime, may, on being mixed with a quantity of sand equal to its volume, constitute a hydraulic mortar, but this mortar is much too meagre to be employed in masonry.

The yellow and white marls, which are very common in Champagne, give good hydraulic cements: I have found some of this kind on the little hills west of the town of Rethel; I have also encountered it at other points in the valleys of the Aisne and of the Maine. These earths mixed with a certain quantity of sand, serve to make bricks which are very light after being burned. When these bricks have not been exposed to a fire of such intensity as to cause a beginning of vitrification, they acquire great hardness under water: several millions of these bricks were made under my inspection, and used in the works of the canal of Ardennes. When the substance of the brick is vitrified, mortar adheres to it but feebly. To form good masses of masonry, bricks of which the substance is not vitrified and which have preserved the red colour, should be preferred; these are, in fact, unpulverized cement, having much affinity for lime, and to which mortars adhere strongly.

Clay, or argillaceous earth—Common Cement.—All clays, or argillaceous earth, not calcareous, burned more or less and pulverized, afford *common cement*. The cement commonly used is made from fragments of bricks or tiles. When the argillaceous earths of which cements are to be made, are exposed to a high degree of heat, they begin to melt and become fritty; in this state the pulverization becomes difficult, and the cement they afford is inert, and but little different from sand.

Of all the common cements that I had occasion to try, the most energetic was derived from the clay of Bédouan, in the department of Ardèche; the results of the analysis of this clay, are to be found in the third column of table LVII.

Experiment No. 15 of table No. LXIII shows that a prism of hydraulic paste, composed of 2 parts of lime and 5 parts of cement, after four months immersion, broke under a weight of 759 lbs.: an equal prism of Theil hydraulic lime, the best that I know, supported only 229 lbs.

Experiment No. 50 of table No. LXIV shows that a mortar composed of 1 part of the above hydraulic paste and 1 part of sand, after four months immersion, broke under a weight of 733 lbs.

Mortar composed of 1 part of Theil lime and 2 parts of sand, broke with a load of 469 lbs.; an equal prism of mortar obtained from a Roman aqueduct, about sixteen centuries old, broke under a load of 519 lbs.

These experiments prove that the hydraulic pastes and mortars which acquire in a short time the greatest strength, are those which are composed of a cement analogous to that furnished by the Bédouan clay.

I concluded the experiments on common cements by seeking to ascertain whether iron would augment the energy of the clay: to this end I mixed with clay different proportions of a ferruginous mineral (carbonate of iron mixed with carbonate of lime) and I pulverized the whole after burning.

The experiments from No. 17 to No. 25 in table LXIII, show the resistances of the hydraulic pastes made of clay-cements and the mineral: experiments from No. 41 to 49 of table No. LXIV, show the resistances of

the mortars composed of this paste. It results from these two series of experiments that the mineral does not augment the energy of the cement, and that it even diminishes it, when the clay contains more than two-thirds of the substance.

ARTICLE XXII.—*Summary and Conclusion.*

From all that precedes, it results, that in going over the combinations that may be obtained by mixing clay not calcareous, and fat lime, in various proportions, we get, first, *hydraulic lime*, which contains as high as $\frac{1}{5}$ of clay; the combinations above this, containing from $\frac{1}{3}$ to $\frac{2}{3}$ of clay, possess at the same time the property of lime and of cement, and for this reason I have designated them as *lime cements;* lastly, the higher combinations, containing from $\frac{3}{5}$ to $\frac{9}{10}$ of clay, may have applied especially to them, the name of *hydraulic cement*, because of their being susceptible of forming hydraulic mortars, alone, or with the addition of a small quantity of lime.

Hydraulic lime.—The properties of hydraulic lime being well known, I have no further occupied myself therewith than was necessary to complete the general examination of the combinations of lime and clay, and to present some observations on the superposition of those calcareous rocks that contain the quantity of clay necessary to produce natural hydraulic limes.

Lime cements.—The combinations that I have called *lime-cements* having been but little examined hitherto, I have given to the study of their different properties, particular care. These combinations burned, pulverized, made into paste and immersed, harden under water very promptly; mixed with an equal volume of sand, or even with a double volume, they give a very good hydraulic mortar; mixed with fat lime at the moment of slaking, they give to this lime a hydraulic power depending on the proportions of the mixture: 2 parts of *lime cement* make 3 parts of fat lime very hydraulic; a still smaller quantity of *lime-cement* might suffice, and but rarely would more be necessary; unless it were thought proper to give to the paste a hydraulic energy superior to that of the best limes.

Very argillaceous limestones, and the greater part of the marls, which are very common in France, give, by moderate burning, natural *lime-cements;* we may therefore give to fat lime, a suitable degree of hydraulic energy, by mixing with it certain quantities of burnt and pulverized marl; the proportions should vary with the energy of the particular kind of pulverized marl at command; but it will be rarely necessary to exceed the proportion of two parts of powdered marl to three parts of fat lime.

At Lyons, and on the canal of Givors, use is made, for works under water, of the eminently hydraulic lime of Theil; but the marls found near these localities, of which I have ascertained the properties, might, on being mixed with fat lime, be substituted advantageously for Theil lime, of which the cubic metre (35.34 cubic feet) costs $8 55. Half of fat lime at $3.04, and half of powdered marl at $1.90, will give a very hydraulic paste, of which the cubic metre will cost only $2.47: the economy that will result from the use of this paste will be very sensible in the prolongation of the canal of Givors, of which the works will consume 10,000 cubic metres of the Theil lime.

In those localities where fuel is dear, and where there is not a supply of either natural hydraulic lime, or of marl susceptible of affording a *lime-cement*, it will be better to use an artificial *lime-cement*, than an artificial hydraulic lime; in fact, in a quantity of hydraulic lime obtained by mix-

ture of fat lime and *lime-cement*, the last substance forming, at most, the half of the total volume, its use will reduce, in this ratio, the cost of burning, and of fabrication; on the other hand, fat lime and *lime-cements* will be more easy to preserve than hydraulic lime; and there will be, moreover, the advantage of varying the degree of hydraulic energy, and of retarding the conversion of fat lime into hydraulic lime until the moment it is to be applied.

Hydraulic cement.—The combinations to which I propose affixing the name of *hydraulic cement*, possess the property of giving, either alone, or mixed with an equal volume of sand, an hydraulic mortar more or less meagre. These cements united with fat lime, form pastes which harden under water, within the space of fifteen days. 1 part of cement suffices to render 2 parts of fat lime hydraulic.

The greater part of argillaceous and calcareous earths—very common every where—are proper to afford hydraulic cements, by burning and pulverization: the burning should be moderated, to prevent the matter from becoming fritty and inert.

When these argillaceous or calcareous earths contain a certain quantity of sand, they serve to make bricks, which are true hydraulic cements not pulverized; these bricks are very light after burning, and appear to want strength unless they have sustained a commencement of vitrification; but they adhere strongly to mortars, and when they are used under water, they soon acquire all requisite hardness; if, during the burning, these bricks are highly heated, they become fritty, often without changing form; but, in this state, they adhere but slightly to mortars, the cement of which they are composed having then become completely inert.

At the canal of Ardennes I had occasion to apply a portion of the preceding observations; because for the works of that part of the canal which lies in the valley of the Aisne there were no other materials than the argillo-calcareous earth covering the bottom of the valley, and the tender, chalky rocks that formed the slopes, together with earth and stones as tender as the chalk.

Different trials made on a small scale showed me, however, that, with care, bricks might be made of the earth from the valley: other trials brought to light, in the gray or chlorite chalk, strata affording hydraulic lime, so that in the course of the years 1826, 1827 and 1828, locks and other works were built with bricks made of the earth of the valley, hydraulic lime from the chalk, and masses of chalk, laid behind the facings of bricks.

Even in a chalky region, where no other materials of construction can be found than chalk, marls, and argillo-calcareous earths, and where, for this reason, the greater number of buildings are of wood, we may, therefore, erect works as solid as elsewhere.

Common cements.—As to *common cements*, I will limit myself to saying that they are the more energetic as they are derived from clays the more refractory: I will say further, that it appears evident to me, the resulting hydraulic pastes and mortars afford more resistance than the analogous mortars composed of hydraulic lime.

Lastly, I will deduce from the second portion of the facts reported by me, that in every locality where limestones, marls, or argillo-calcareous earths are to be found, hydraulic pastes and hydraulic mortars may be obtained at small expense; and that the resistances of one and the other may be caused to vary from 44 lbs. to 759 lbs. for prisms 2 inches long by 1 $\frac{8}{10}$ inch square.

Such are the observations I have had occasion to make: I know they are very incomplete, and that enough has not been done to show the influence of time on the resistance of pastes and hydraulic mortars: but if the results at which I have arrived are deemed worthy of the attention of constructors, I shall have attained the object, I proposed to myself.

Table No. LVII.

Analyses of several natural combinations of lime and clay, susceptible of giving after burning, hydraulic pastes, either alone or mixed with fat lime.

		Brick earth from Rive-de-gier.	White clay from Rive-de-Gier.	Clay from Bédoreau	Limestone from Theil.	MARLS				Remarks.
						From Echaur.	From St. Just.	From Aubigny,	From Givors.	
		1	2	3	4	5	6	7	8	
Water . .		8.00	5.80	12.00	3.00	6.20	6.80	12.20	13.20	These analyses were made at the School of Mines of St. Etienne, by M. Socart, Chemist. I am indebted for them to Messrs Delecrès and Clapeyron, Engineers of Mines.
Carbonate of lime			9.20		76.80	53.20	35.40	24.80	23.80	
Carbonate of magnesia			1.60		trace	2.00	1.20	0.00	0.80	
					79.80	61.40	43.40	37.00	37.80	
CLAY	Silex .	57.80	60.00	52.00	14.40	22.00	26.00	38.40	39.60	
	Alumine .	19.60	14.80	28.00	2.80	7.20	15.00	11.60	7.00	
	Lime .	2.00		3.00	1.20	1.40	2.00	5.40	8.40	
	Magnesia	0.00		1.00	0.40	0.00	1.20	0.00	1.60	
	Oxide of iron	12.40	8.40	2.00	0.80	7.60	11.60	7.20	4.80	
Totals . .		99.80	99.80	98.00	99.40	99.20	99.20	99.60	89.60	

Table LVIII.

Analyses of natural combinations of lime and clay—extracted from the work of Gen. Treussart.

	Clays.			Hydraulic Lime.			Lime Cements.			Hydraulic Cements.		
	Pipe clay from Cologne.	From Frankfort.	From Suffenheim.	From Saint Germain.	From Metz.	From Senonches.	Parker's cement, (English.)	Boulogne pebbles.	Cement from Pouilly.	Puzzolana.	Trass.	Calcined Basalt from Haute Loire.
	9	10	11	12	13	14	15	16	17	18	19	20
Water	6.60	16.00	7.80							9.20	9.60	2.00
Lime				83.00	68.30	70.00	55.40	54.00	42.86	8.80	2.60	9.50
Clay: Silex	67.00	50.00	72.40							44.50	57.00	44.50
Clay: Alumine	24.00	32.70	11.80							15.00	12.00	16.75
Clay				clay	clay	clay	clay	clay	clay			
Clay: Magnesia	1.20	1.50	2.00	17.00	31.70	30	44.60	46.00	57.14	4.70	1.00	
Clay: Peroxide of Iron	1.20		4.80							12.00	5.00	20.00
Potassa										1.40	7.00	
Soda										4.00	1.00	2.60
Oxide of Manganese												2.37
Totals	100.00	100.20	98.80	100.00	100.00	100.00	100.00	100.00	100.00	99.60	99.20	97.72

Table LIX.

Degree of penetration of a stem 0.047 inch in diameter, and $\frac{2}{3}$ of a pound av. in weight, falling from a height of 0.787 inch upon prisms of artificial hydraulic paste, immersed for 15 days.

General Classification.	Substances (a) or combinations of the first order.	Combinations of the second order, or artificial hydraulic pastes, formed of a mixture of each substance (a) or combination of the first order, in various proportions with fat lime—the proportion being as follows, viz:									
		Substance (a) 10 Fat lime 0	9 1	8 2	7 3	6 4	5 5	4 6	3 7	2 8	1 9
		inch	inch	inch	inch	inch	inch	inch	inch	inch	inch
Common cement	10 of burnt clay, 0 of lime	1.772	0.000	0.000	0.000	0.000	0.039	0.118	0.118	0.118	0.275
Hydraulic cement	9 of burnt clay, 1 of lime	0.039	0.000	0.000	0.000	0.078	0.078	0.118	0.078	0.590	0.512
	8 of burnt clay, 2 of lime	0.039	0.039	0.000	0.000	0.078	0.039	0.078	0.472	0.156	0.195
	7 of burnt clay, 3 of lime	0.039	0.039	0.039	0.078	0.156	0.039	0.078	0.156	0.236	0.275
Lime cement	6 of burnt clay, 4 of lime	0.078	0.118	0.078	0.039	0.039	0.078	0.236	0.118	0.551	0.236
	5 of burnt clay, 5 of lime	0.000	0.000	0.000	0.078	0.078	0.039	0.118	0.118	0.118	0.118
	4 of burnt clay, 6 of lime	0.000	0.039	0.039	0.118	0.118	0.039	0.195	0.195	0.195	0.275
	3 of burnt clay, 7 of lime	0.000	0.078	0.078	0.118	0.078	0.118	0.236	0.118	0.118	0.118
Hydraulic lime	2 of burnt clay, 8 of lime	0.118	0.078	0.156	0.156	0.156	0.236	0.473	0.195	0.275	0.195
	1 of burnt clay, 9 of lime	0.394	0.472	0.195	0.195	0.195	0.787	0.195	0.669	0.787	1.575
Fat lime	0 of burnt clay, 10 of lime	1.772									

Table LX.

Degree of penetration of a stem 0.047 inch in diameter, and $\frac{2}{3}$ of a pound avoirdupois in weight, falling from a height of 1.575 inch upon prisms of artificial hydraulic paste, immersed for two months.

General Classification.	Substances (a) or combinations of the first order.	Combinations of the second order, or artificial hydraulic pastes, formed of a mixture of each substance (a) or combination of the first order, in various proportions with fat lime—the proportions being as follows, viz:									
		Substance (a) / Fat lime	10 / 0	9 / 1	8 / 2	7 / 3	6 / 4	5 / 5	4 / 6	3 / 7	2 / 8	1 / 9
		inch		inch	inch	inch	inch	inch	inch	inch	inch	inch
Common cement	10 of burnt clay, 0 of lime	1.772		0.000	0.000	0.009	0.039	0.078	0.118	0.118	0.156	0.275
Hydraulic cement	9 of clay, 1 of lime	0.078		0.159	0.000	0.000	0.039	0.039	0.039	0.039	0.078	0.118
	8 of clay, 2 of lime	0.078		0.019	0.000	0.000	0.000	0.019	0.019	0.039	0.078	0.118
	7 of clay, 3 of lime	0.039		0.039	0.000	0.019	0.019	0.019	0.039	0.078	0.118	0.275
Lime cement	6 of clay, 4 of lime	0.039		0.039	0.039	0.019	0.039	0.059	0.078	0.078	0.118	0.118
	5 of clay, 5 of lime	0.000		0.000	0.000	0.019	0.019	0.039	0.039	0.039	0.078	0.078
	4 of clay, 6 of lime	0.000		0.039	0.019	0.078	0.078	0.118	0.078	0.078	0.078	0.118
	3 of clay, 7 of lime	0.000		0.019	0.195	0.039	0.039	0.059	0.078	0.098	0.118	0.118
Hydraulic lime	2 of clay, 8 of lime	0.039		0.078	0.118	0.118	0.118	0.118	0.156	0.156	0.118	0.118
	1 of clay, 9 of lime	0.118		0.156	0.118	0.118	0.236	0.393	0.275	0.315	0.315	0.315
Fat lime	0 of clay, 10 of lime	1.772										

Table LXI.

Weights that broke the prisms of artificial hydraulic paste—immersed for four months.

General classification.	Substance (a) or combinations of the first order.	Combination of the second order, or artificial hydraulic pastes formed of a mixture of each substance (a) or combination of the first order in various proportions with fat lime—the proportions being as follows, viz:									
		Substances (a) 10 / Fat lime 0	9 / 1	8 / 2	7 / 3	6 / 4	5 / 5	4 / 6	3 / 7	2 / 8	1 / 9
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Common cement	10 of burnt clay, 0 of lime	0	209	334	356	290	229	143	139	59	33
Hydraulic cements	9 of clay, 1 of lime	59	262	297	255	297	218	180	194	121	19
	8 of clay, 2 of lime	33	321	249	363	319	275	235	125	154	44
	7 of clay, 3 of lime	194	356	350	257	205	300	119	143	73	55
	6 of clay, 4 of lime	152	249	229	255	255	185	141	130	68	53
Lime cements	5 of clay, 5 of lime	438	235	387	185	180	341	194	132	99	48
	4 of clay, 6 of lime	396	183	275	172	200	119	121	108	99	64
	3 of clay, 7 of lime	194	178	304	156	147	136	77	161	123	79
Hydraulic cements	2 of clay, 8 of lime	139	207	114	134	152	0	81	106	84	53
	1 of clay, 9 of lime	70	75	86	97	51	44	40	33	33	29

Table LXII.

Weights which broke prisms of *mortar* or combinations of the third order—immersed during four months, and composed of the several artificial hydraulic pastes mentioned in the preceding table—mixed with double the volume of sand.

General classification.	Substances (a) or combinations of the first order.	Combinations of the third order, or mortars made by mixing each of the hydraulic pastes of the second order mentioned below—with double its volume of sand NB. The several hydraulic pastes are composed as in the preceding tables, viz.									
		Substance (a) 10 Fat lime 0	9 1	8 2	7 3	6 4	5 5	4 6	3 7	2 8	1 9
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Common cement	10 of burnt clay 0 of lime	0	161	99	183	169	185	132	123	79	75
Hydraulic cement	9 of clay 1 of lime	48	147	163	143	183	185	205	114	117	55
	8 of clay 2 of lime	73	128	167	174	161	326	198	134	183	141
	7 of clay 3 of lime	95	187	147	128	200	123	167	106	119	44
Lime cement	6 of clay 4 of lime	75	222	209	198	169	224	158	114	141	55
	5 of clay 5 of lime	185	75	200	209	218	178	154	139	119	70
	4 of clay 6 of lime	51	350	290	407	277	165	156	187	141	176
	3 of clay 7 of lime	152	156	218	275	202	249	101	202	172	211
Hydraulic lime	2 of clay 8 of lime	150	187	145	172	145	191	200	150	134	121
	1 of clay 9 of lime	143	128	152	167	134	112	106	55	70	73

Table LXIII.

Resistance to rupture of prisms of paste of various natural hydraulic substances.

Nos. in the series.	Nature of the hydraulic paste.	Age of the paste or duration of immersion.	Fat lime and Hydraulic lime.	Hydraulic cement and lime cement.	Weight which caused rupture.
					lbs.
1	Theil lime	4 mo.	1	0	228
2	Pouilly cement	do.	0	1	431
3	Givors' marl alone	2 mo.	0	1	222
4	do. and fat lime	do.	4	6	165
5	St. Just marl, and fat lime	do.	2	8	361
6	do.	do.	3	7	312
7	do.	do.	6	4	167
8	do.	do.	7	3	132
9	do.	do.	8	2	88
10	do.	do.	9	1	77
11	Aubigny marl, alone	4 mo.	0	1	154
12	do. and fat lime	do.	1	9	141
13	do.	do.	2	8	66
14	do.	do.	3	7	44
15	Cement from Bédouan clay and fat lime	do.	2	5	759
16	Prism of burnt earth	do.			194
	Clay cements and a ferruginous cement burnt together and pulverized.				
17	9 of clay and 1 of the minerals	3 mo.	2	5	209
18	8 do. 2 do.	do.	2	5	218
19	7 do. 3 do.	do.	2	5	308
20	6 do. 4 do.	do.	2	5	114
21	5 do. 5 do.	do.	2	5	216
22	4 do. 6 do.	do.	2	5	273
23	3 do. 7 do.	do.	2	5	224
24	2 do. 8 do.	do.	2	5	136
25	1 do. 9 do.	do.	2	5	112

Table LXIV.

Resistance to rupture of prisms of different mortars—made with natural hydraulic pastes.

Nos. in the series.	Nature of the hydraulic paste used in making this mortar.	Age of the mortars or duration of immersion.	Fat limes and Hydraulic lime.	Hydraulic cement and lime cement.	Silecious Sand from Givors.	Weights that caused the rupture.
	Hydraulic Limes.					lbs.
1	Lime from Chanay near Macon	4 mo.	1	0	2.00	39.6
2	do. Sury (Loire)	do.	1	0	2.00	66.0
3	do. Theil (Ardèche)	do.	1	0	2.00	469.0
4	do.	1 mo.	1	0	1.00	75.0
5	do.	do.	1	0	1.50	81.0
6	do.	do.	1	0	2.00	66.0

Table LXIV.—Continued.

Nos in the series.	Nature of the hydraulic paste used in making the mortar.	Age of mortar or duration of immersion.	Fat lime and Hydraulic lime.	Hydraulic cement and lime cement.	Siliceous sand from Givors.	Weights that caused the rupture.
	Hydraulic limes.					lbs.
7	Lime from Theil (Ardèche)	1 mo.	1	0	2.50	68.2
8	do.	do.	1	0	3.00	66.0
9	do.	do.	1	0	3.50	63.8
10	do.	do.	1	0	4.00	69.4
11	Saint-Leger cement, near Châlons-sur-Saône	4 mo.	0	1	2.00	160.6
12	Pouilly cement	do.	0	1	2.00	297.0
13	Marl from Givors, alone	1 mo.	0	1	2.00	50.6
14	do. and fat lime	do.	1	1	3.00	88.0
15	do.	do.	1	1	1.00	105.6
16	do.	do.	1	1	1.20	101.2
17	do.	do.	1	1	1.40	121.0
18	do.	do.	1	1	1.60	138.6
19	do.	do.	1	1	1.80	107.8
20	do.	do.	1	1	2.00	136.4
21	do.	do.	1	1	2.20	118.8
22	do.	do.	1	1	2.40	134.2
23	Marl from Givors, alone	do.	0	2	1.00	224.4
24	do.	do.	0	3	2.00	94.6
25	do.	do.	0	6	5.00	44.0
26	do.	do.	0	1	3.00	37.4
27	Marl from St. Just, and fat lime	4 mo.	4	6	20.00	143.0
28	do.	do.	5	5	20.00	92.4
29	do.	do.	6	4	20.00	77.0
30	Marl from Aubigny, alone,	do.	0	1	2.00	35.2
31	do. and fat lime	do.	1	9	20.00	70.4
32	do.	do.	2	8	20.00	74 8
33	do.	do.	3	7	20.00	125.4
34	do.	do.	4	6	20.00	173.8
35	do.	do.	5	5	20.00	94.6
36	do.	do.	6	4	20.00	70.4
37	do.	do.	7	3	20.00	101.2
38	do.	do.	8	2	20.00	37.4
39	do.	do.	9	1	20.00	52.8
40	do.	do.	5	5	15.00	121.0
	Lime cements and clay cements mixed with the ferruginous mineral.					
41	9 of clay and 1 of the mineral	do.	4	10	14.00	583.0
42	8 do. 2 do.	do.	4	10	14.00	294.8
43	7 do. 3 do.	do.	4	10	14.00	242.0
44	6 do. 4 do.	do.	4	10	14.00	134.0
45	5 do. 5 do.	do.	4	10	14.00	224.4
46	4 do. 6 do.	do.	4	10	14.00	319.0
47	3 do. 7 do.	do.	4	10	14.00	145.2
48	2 do. 8 do.	do.	4	10	14.00	127.6
49	1 do. 9 do.	do.	4	10	14.00	105.6
50	Fat lime and Bedouan clay	do.	4	10	14.00	732.6
51	Lime and clay from Rive-de-Geir	do.	4	10	14.00	642.4
52	Mortar from a Roman aqueduct	18 cen.				519.2
53	Prism of burnt earth					293.8

(TO BE CONTINUED.)

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

New mode of obtaining Metallic Osmium. By Professor Ellet.

The residue of the ore of Platinum after the action of the nitro-muriatic acid, and which consists principally of osmium and iridium is to be intimately mixed with an equal weight of chlorate of potassa, and the mass introduced into a green glass retort. On the application of a heat approaching to redness, the mass becomes suddenly ignited and a torrent of mixed oxide of osmium and free oxygen passes over. If the neck of the retort be inserted in a deep vessel of strong liquid ammonia, an *osmiate of ammonia* is formed and remains in solution, while the excess of oxygen escapes in bubbles. The solution of osmiate of ammonia by careful evaporation yields an imperfectly crystallized mass of prisms of a brown colour. These are to be introduced into a glass tube closed at one extremity and exposed in the flame of a spirit lamp, to a temperature of 400° to 500° Fahr. The mouth of the tube should be closed by the thumb. Decomposition ensues, the hydrogen of the ammonia decomposing the oxide, with the evolution of aqueous vapour and nitrogen gas, which is instantaneous, and is remarked by a sensible pressure on the thumb. The residual solid contents of the tube will be pure metallic osmium—in the form of a black powder.

If it be desired to exhibit the metallic lustre of the osmium, we may introduce a portion of the ammoniacal osmiate into a very small retort, pour upon it an excess of sulphuric acid—and apply a moderate heat. Osmic acid will be volatized. If now a stream of hydrogen gas be introduced into the neck of the retort, so as to blend with the osmic acid vapors, and the neck be heated to redness by means of a Cooper's lamp, reduction takes place, and a crust of metallic osmium, having the lustre and brilliancy of silex, lines the tubes

South Carolina College, Columbia, S. C. May 7th, 1838.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

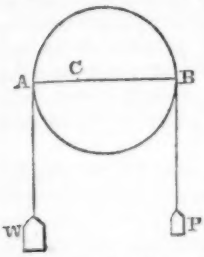
The following remarks, on a subject recently discussed in the Journal, are offered for insertion, by Trochilia.

The method by which some writers explain the properties of the pulley, regarding it as a lever of the first or second order, and which has been insisted on, in a late number of the "Journal," will appear upon a slight examination, to be unfounded, and to lead to false results.

The method in question is unfounded, because, it supposes a power applied, where, aside from the consideration of friction, none exists. A rope moving in the groove of a pulley exerts no tendency to turn it on its axis, except what arises from friction,—the very defect of the instrument which the pulley, properly so called, is intended to obviate. The mistaken notion that the pulley, like the wheel and axle, is only a modification of the lever, has evidently arisen from the fact that the pulley actually turns, and that one extremity of its horizontal diameter does, in the movable pulley, for an infinitely small portion of time, move through twice the space passed over by the weight attached to the centre, while the other extremity of the diameter remains for an instant stationary; indeed, inasmuch as the pulley turns on its axis, *it is a lever*; but the power applied to it, is not that which raises the weight, but only that portion of it which is lost in consequence

of friction; and since the theoretical consideration of a mechanical power should have no reference to friction, it is plain that the idea of a lever should be excluded from our reasoning upon the pulley.

Let us suppose a pulley to be so constructed that its centre of gravity shall be at C; A, C, being supposed half of B, C, and let C, be the centre of motion of the pulley,—then, if the lever principle is applicable, a weight W, of two pounds, and a power P, of one pound should be in equilibrium: but the fact evidently is that W, would descend in consequence of the excess of its gravity over that of P. Disregarding the weight of the string, the centre of gravity of the system composed of the pulley, the power and the weight would evidently be in the vertical line drawn through C, and this being the case, there would be no tendency in the pulley to change its position during the descent of W, except so far as it would be affected by friction;—indeed any motion of the pulley must necessarily throw the common centre of gravity of the weight and power out of the perpendicular line in which it will descend if the pulley remain stationary.



I have confined my remarks to the fixed pulley for the sake of simplicity, but the assumption of the lever principle, will apply in whatever form the pulley may be used.

Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN AUGUST, 1837.

With Remarks and Exemplifications by the Editor.

235. For a machine for *Spreading Adhesive and other Plasters;* B. Morison, Milton, Northumberland county, Pennsylvania, August 8.

A metallic trough is made, which has two sides sloping towards each other at bottom, but they do not meet, the bottom being open for the length of the trough. This trough fits on to a metal roller, which may be about five inches in diameter; below this there is a wooden roller upon which the cloth to be spread is wound. The outer end of this cloth is to be passed between the metal roller and the trough, which are secured at such distance apart as to allow for it, and for the thickness to be given to the plaster; this latter is to be brought to a semi-fluid state by heat, and poured into the trough. It is then drawn out by an assistant, whilst another turns a winch upon the axis of the metal roller, to cause the cloth to pass readily through; this unwinds the cloth from the wooden roller, which is kept from too free a motion by corks bearing against its gudgeons. The claims made include the general structure of the machine as described.

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236. For an improvement in the *Rotary Steam Engine;* Ashur Miller, Lockport, Niagara county, New York, August 8.

The nature of the invention, we are told, "consists in a revolving piston, and in applying the steam thereto by means of a side pipe, eccentric, or cam, and shifting or slide valve, as ordinarily applied to a reciprocating en-

gine, thereby giving the piston a perfect rotary motion; which may be constructed on the high or low pressure principle." The patentee says that his engine "will be recommended by its simplicity. It will require less machinery than engines now in use, and thus avoid much friction. And the inventor believes it will give more power with the same quantity of steam than any engine now in use. Another advantage gained over the common reciprocating engine is the continued, constant, and equal, pressure of the steam upon the piston in one direction, thus avoiding those dead points at which, in the common reciprocating engine, foreign aid is required to start it." The claim is to "the combination of the shifting or slide valve with the rotary piston, as in the above specification."

This engine is, in general, the counterpart of some which have long been in the field, or rather on the shelf. The revolving piston has nothing new in it, but in the side pipes and slide valve there may, and it is believed there is, novelty, but unaccompanied by any thing tending to remove the faults which have consigned a host of rotary engines to oblivion. The slide valve, on the top of the engine, is to admit steam alternately into two hinged valves, placed opposite to each other; but what better effect this is to produce on the revolving piston we cannot perceive. The slide valve and its appurtenances do not, certainly, simplify the arrangement, and ought therefore to produce some substantial benefit. Should a condenser be added to work it on the low pressure principle, there would be another source of complexity, but scarcely of utility. Without hoping that there will, we are not prepared so say that there will not, be discovered a rotary engine of moderate power, and equally economical and durable with the reciprocating; but we have no hope that the one before us will take this station.

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237. For an improved mode of *Applying Warm Air to Fires;* John Silsbe, Tyrone, Steuben county, New York, August 8.

Whether this contrivance is for forge backs, for common fires, or for fires of all descriptions, we are not told. It appears, however, that there is to be a metal box, cast-iron we suppose, into which the air is to pass through a hole in the back plate, whether by blowing, or spontaneously, we know not. In the front plate there is to be a longitudinal opening, say five inches long, and half an inch wide, enlarging inwards. Three plugs, or stoppers, ranged side by side, are to close these openings if required. Three rods cross the interior of the box, and pass through the back plate, to govern the three stoppers. The mouth piece is made separate from the box, so that it can be renewed. We have told all.

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238. For a *Substitute for Gum Senegal;* Walter Leversidge, Dorchester, Norfolk county, Massachusetts; Patent issued in August, but dated May 30. (See Specification.)

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239. For a machine for *Riving, Planing, and Jointing, Shingles;* Enoch R. Morrison, Pittsburgh, Alleghany county, Pennsylvania; issued in August, but dated June 15.

There is considerable novelty in the arrangement of the respective parts of this machine, although all the operations intended to be performed by it have been previously performed by means not differing essentially from those described; in the claim, therefore, the arrangement and combination described are the points upon which dependance is placed. There is an

apparent complexity in the machine, but probably not more than is necessary where the three operations of riving, planing, and jointing are to go on simultaneously.

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240. For an improvement in *Grates and Stoves;* Edward H. Dixon, New York, August 8.

The fire place, under the arrangement proposed, is to be enclosed by sliding doors, glazed, or furnished with plates of mica. In the drawing, these doors are represented as sliding into jambs in the form of Gothic towers. The claim is to the combination of the glass, or mica, door, (as applied to grates and stoves) sliding on rods or flanches, either vertically, entire, or divided, and received behind the towers on either side the fire, substantially as described; together with the pipes and valves, as arranged with the various parts together as described, to attain the effect of warming the apartment, with constant ventilation, preventing currents of air, and the escape of gas and ashes into the apartment."

Such an affair may be made to look very pretty, undoubtedly; but the enclosing the fire by means of sash will scarcely be found economical or convenient. More of the heat will be carried off by the draught, and less be diffused by radiation, we apprehend, than from an ordinary open fire; this opening and closing of sash, whenever the fire requires attention, will also be a trial of patience both to the idle and to the industrious, although from different considerations.

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241. For improvements in the common *Crank Power Loom;* Enoch Burt, Manchester, Hartford county, Connecticut; Patent issued in August, but dated February 10.

The patentee claims a particular mode of moving the shuttle box by a curvilinear cam co-operating with a horizontal lever and perpendicular rod. A particular apparatus for varying the figure is also claimed; and two modes of forming what is denominated a thread protection; which are contrivances for causing the power loom to stop when a thread breaks; by one of these the shuttle is prevented from boxing by the breaking of the bobbin thread, or from the bobbin being spent. We cannot give a description of these plans without engravings; nor could it be briefly done even with these aids.

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242. For improvements in *Cooking Stoves;* Samuel Utter, City of New York, August 8.

The claim in this stove is to "the construction of a heated air chamber under, and at the ends of, the oven of a cooking stove; which chamber is unconnected with the flues that pass over or around the oven; and which air, when heated by the fire in the stove, or grate, is admitted freely into the oven through openings made in the bottom plate thereof for that purpose." The construction of a chamber for heating air is not claimed "excepting in connexion with the openings in the bottom plate of the oven through which it is to pass, this being its sole use."

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243. For an improvement in the machine for *Teazling, or Napping, Cloth;* Benjamin Swazey, Mount Pleasant, Maine, August 8.

The claims made under this patent refer to a mode of fixing the teazles on wires, on the napping cylinder, and to a particular mode of fixing springs

in the cloth rolls, and of throwing the rolls in and out of gear, keeping it in contact with the teazles as it is wound forward, and removing it as it is wound backward.

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244. For *Stoves for Cooking;* James Wilson, City of New York, August 15.

The claims to the respective parts of this stove are of considerable length, and need not be given, as they relate to the particular modes of constructing, arranging and combining, plates, dampers, and flues in the way shown in the drawings.

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245. For improvements in *Machinery for Doubling and Twisting Sewing Silk, Worsted, Cotton and Linen Thread;* John Golding, Dedham, Massachusetts, August 15.

The claim made is to the arrangement of machinery which by the breaking of the thread stops the spindle, and throws the feeding-down-roller up, and prevents the thread from running to waste.

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246. For a *Safe for the Preservation of Papers*, which can be used as a writing desk; Daniel Fitzgerald, city of New York, August 15.

A case of sheet-iron lined with some bad, and incombustible, conductor of heat, is fixed beneath a table, or desk; the top of this box is open, and it is to receive a case, made of similar materials, for containing books and papers. This latter case is made to descend into the former, or to be raised from it, by a windlass and chain. When up, it forms a part of the writing desk, and when down, its top forms the cover of the case first named, and is flush with the table part of the desk. When the safe is raised, its doors, which are hinged at their bottom edges, fall, and form the table to write on. The claims are to the "forming a writing table of the door of the safe, or raising chest, or case. The combination of safe and desk, or writing table."

We cannot well conceive of a less promising affair than the foregoing, which could pass examination in the patent office; but things are not stopped there merely because they are trifling, provided they present any novelty and do not violate the known laws of mechanical, or of chemical philosophy. The iron part of the above described instrument is, at best, but a small iron chest, or safe, without the pretence of any new means of safety from fire.

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247. For an improved *Smut Mill;* Charles D. Childs, Mount Morris, Livingston county, New York, August 15.

The outer shell of this smut mill has the general form of a vertical cylinder, but consists of separate rings piled one above the other, the lower edge of an upper, entering within the upper edge of a lower ring, throughout the series, there being an open space left between each ring for the passage of air and dust. The inner sides of these rings are surrounded by five vertical flutes. Within the body thus formed, there is a revolving cylindrical rubber, consisting also of sections of metal, covered with teeth, and approaching the inside of the outer shell. There are protuberances of this revolving part which agitate the grain as it passes down from the feeding hole in the upper plate of the machine. The claim is to "the manner of forming and combining the cast-iron rings; leaving the annular openings for the escape of air, dust, and smut; and the manner of constructing and using the revolving fluted rasps, formed and operating as described."

248. For a *Press for Pressing Cheese and other Articles;* Sullivan White, Bridgewater, Windsor county, Vermont, August 15.

In Vol. XVI. p. 174, there is an engraving and description of a self-adjusting cheese press. That now before us is also upon the self-adjusting principle, in which the weight of the article to be pressed acts in producing the pressure, but there is considerable difference in the arrangement of the parts. The claim made is to "the arrangement and combination of friction rollers, levers, and sliding frame, by which the weight of the sliding frame, cheese, and if necessary, other weights, causes the action of the levers to be such that their power is increased in proportion to the descent of the sliding frame, so as to secure an adequate pressure at the commencement of the operation, and an increasing power in proportion to the ascent of the sliding frame; thus applying the power when and where most required."

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249. For a *Machine for Cutting Shingles and Siding from Steamed Timber;* Joseph S. Raymond, Lodi, Cattaragus county, New York, August 15.

A wheel is to be made of about eight feet in diameter, and this is to revolve vertically on its axis. Two knives are placed on one face of this wheel, of such length as may be required by the shingle to be cut. These knives are opposite to each other, extending from near the periphery towards the centre of the wheel. They are distant from the wheel so far as is required for the thickness of the shingle, and the distance varying at the two ends according to the slope of the shingle. They stand in reversed positions in this last respect, one of the knives cutting the thick, and the other, the thin, end of the shingle towards the periphery of the wheel. The shingles as they are cut pass through openings in the wheel, in the manner of the throat of a plane. The stuff is laid upon a bed and fed up by the action of weights. The bed is made to vibrate by projecting, inclined pieces on the face of the wheel.

The claims are to the reversed position of the knives; the manner of vibrating the bed upon which the stuff lies; and to a lever and knife for edging. The cutting by knives on the face of the wheel is disclaimed, as not being new, leaving the features of novelty not of a very prominent character.

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250. For an improvement in the construction of *Rain Water Cisterns*; George W. Blenis, Salina, New York, August 18.

The cisterns, of hydraulic lime, are to be constructed with their bottoms in the form of an inverted dome, in situations where the soil is wet, to enable them to resist the upward pressure of the external water.

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251. For a *Mode of applying a compound resinous Cement in making Cisterns, Reservoirs, Piers, &c.;* Thomas Coyle, Baltimore, August 18.

There is no novelty in the composition of this cement, which is formed of one part of rosin and two parts of dried clay finely pulverised. These are to be incorporated in a kettle, over a fire, and heated until of a dark brown colour, when it will become so tough as not to crack in the cold, and so hard that the heat of the sun will not make it soft. The specification describes the mode of applying it to the walls and floors of cellars, to reservoirs, &c., and then adds, "although I have described the manner of

using and applying this cement for various purposes, I wish it to be distinctly understood that I do not claim to be the inventor of the cement itself, or of its application to keep out moisture in cellars, vaults, &c.: nor do I claim the application thereof to such purposes in a heated state, this being necessary in all cases, and a thing well known. But what I do claim as my discovery is the applying it, (in places, or vessels, which contain water,) so highly heated as that it shall expel the moisture therefrom, so as effectually to adhere to pebbles, stones, wood, and other substances with which it comes into contact."

It is proposed to form piers, or columns, in water, by filling a box, or casing, with stones, and then pouring in the cement in a highly heated state, which it is averred, will disgorge the water, and heat the stones, so as to secure perfect adhesion, and great solidity in the mass.

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252. For an improvement in the *Strainers for Milk Pails;* Isaiah Bunnell, Darby, New Haven county, Connecticut, August 18.

The lip, or spout, of a milk pail, instead of being punched full of small holes in the usual way, is to have a piece of wire gauze soldered in its place. "This pail is used for milking, and the milk is perfectly strained by simply pouring it through the spout into the receiving vessel."

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253. For an improvement in the mode of constructing *Paddle Wheels for propelling boats, &c.;* John S. Greenough, Boston, Massachusetts, August 18.

"This wheel consists of an axle, arms, buckets with cranks, balance or guide wheels, latch bolts for bracing the buckets in their proper position, with lifters or followers for raising the latch bolt, and returning it to its place again, and friction wheels to confine the guide wheels in their place. The improvement here claimed is the manner in which the buckets are kept parallel, and either vertical, or at any angle, as deemed most efficacious in propelling."

A host of wheels have been contrived with a view to giving the paddles a vertical, or nearly vertical, position; and many of them have been tried at great expense, and have been abandoned; boats have been kept running for a considerable length of time with such wheels, with no other discoverable advantage than by more frequent want of repair, affording employment to the workman: one, or more, is now on trial in Europe, and flattering accounts of advantageous results have been received, but we are incredulous, and will not admit the testimony until it has been confirmed by time. The plan before us does not differ in principle from that adopted by others, but the mode of arrangement is varied, and for this the patent is taken. There have been some more simple, and some more complex; the particular difference between this and other members of the vertical paddle family, cannot be made clearly known without a full description and drawings, and these we promise as soon as it goes into successful operation.

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254. For an improved mode of applying the *Bow and Worm Spring to Saddles;* Jonathan Keedy, Russelville, Logan county, Kentucky, August 18.

In the kind of spring applied to the saddle, as described in the specification, there is no claim made to novelty, but only to the manner in which it is arranged; which, however, does not present any thing of apparent importance.

255. For improved *Tongs, or Grappling Irons, for raising bodies from under water;* Ebenezer and Thomas J. Lobdell, city of Boston, Massachusetts, August 18.

These grappling irons are constructed in several different modes, according to the nature of the article which they are intended to raise; those for bars of iron, for example, differing in certain points from such as are to take hold of large stones; the principal novelty about them consists in the addition of wings, or bearing frames; and these constitute the claim. We shall not attempt to describe the various forms of the instrument, for although there may be some novelty in them, it is not to be supposed that, in the numerous cases where such things have been required and used, they have not been differently constructed and adopted to the object in view.

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256. For improvements in *Wind Mills;* Ebenezer Sperry, Wenham, Essex county, Massachusetts, August 31.

In this wind-mill the power of the wind is to be obtained in a square building, or tower, which may be from ten to fifteen feet square, and from fifteen to twenty feet in height, and this is to be enclosed at its base by eight doors, through which the wind is to be admitted, and by which its force is to be regulated. There are to be partitions, or wing walls, extending out between these doors to catch and condense the wind. Within this building there is to be a vertical shaft, from which successive circles of arms are to proceed, one above the other, like the spokes of a wheel; of these circles there may be four, five, or more; to the arms are attached vanes, or oblique wings, standing in the position of the vanes of a common ventilator. These circles of vanes are to increase in diameter as they rise one above the other. In the drawing, the tower is represented as roofed in, and having openings on each side containing blinds. The claims are to,

1st. The aforesaid construction and arrangement of buildings, or of more simple and less expensive structures, presenting, in the manner aforesaid, an extended surface, for the purpose of condensing and concentrating the currents of air, and throwing the whole force thus concentrated and condensed, directly upon the arms of the wind-mill.

"2nd. A series of arms on the same vertical shaft, or axis, which, while they receive the whole power of the air condensed and concentrated in the manner and by the means aforesaid, operate so as, in a great measure, to equalize the action of said power, while, at the same time, by means of their peculiar structure as aforesaid, they present as little resistance to the air as possible.

"3rd. The means used for letting off an excess of wind, by waste gates and doors, and for increasing its power by the use of canvas, or sail cloth, or other suitable materials."

To a mill of this construction, the objections appear to us to be numerous, and of such a nature, as seem well calculated to render this uncertain power less efficient than in mills of the ordinary construction. The attempts at giving to wind-mills a form and arrangement which shall render this power more available than in the Dutch mill, have, we believe, been in all instances a failure. Such we know has been the case with the horizontal mills, generally, and these, we apprehend, are the second best. In applying fluids to move machinery, there is much loss of power from sud-

den and great changes of direction, and in the mill before us this objection is very far from being removed.

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257. For *self-loading and priming Fire Arms;* Silas Day, city of New York, August 31.

It is not necessary to give the claims in the present case, as these would afford no information respecting the construction of the parts referred to in it; nor do we think it necessary to attempt a description of an arrangement which we apprehend will share the fate of nine-tenths of the improved fire arms, which now stand upon the lists of the Patent Office.

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258. For an improvement in *Ship Building*; Samuel E. Howell, Vincent town, Burlington county, New Jersey, August 31.

The claim is to "the forming the bows of vessels of a large class, in a regular curve; without a cut water, and in forming the keel in the section of a cone." What is meant by forming the keel in the section of a cone, is, that it flares out on each side, so that it is considerably wider at its lower side, along its whole length, than it is where it joins the bottom of the vessel. The advantages assigned to a vessel constructed with a bow of a regular curve, and without a cut water, are, that she will answer more readily to her helm, and will bear more beam than one with a sharp bow; that her greatest breadth of beam may be far forward, which will give her a larger sailing floor: that she will turn to windward more readily than a sharp ship; will ride at anchor much easier; will not gripe, or shear; will bear to have her masts without rake, and that the sails will consequently set more fair to the wind. The advantage of the form of keel described, is said to be that when the ship keels over with the wind, the lee side will present a perpendicular side to the water, which will hold the better to windward; a few additional inches to the width of keel making up for the deficiency of the cut water to the forward keel. Let nautical men judge of all this.

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259. For a *Quadrant Hinge for Stoves*; Ebenezer Barrows, Boston, Massachusetts, August 31.

This is a very convenient affair for oven doors, the doors falling down, and presenting a useful horizontal hearth. The claim is to "the contrivance or structure described, as resembling the quadrant, somewhat, in form, applied to the purpose described. Also the improvement whereby the hinge is cast in one piece with the door-leaf, or damper; requiring only a mortise or jog in the door frame, to complete the hanging of the door-leaf, or damper. Also the combination of the above description of hinge with the improvement of casting it in one piece with the door-leaf, or damper.

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260. For an improved *Yoke for Horses or Oxen*; Gideon Hotchkiss, Windsor, Broome county, New York, August 31.

Should farmers in general adopt the yoke which forms the subject of this patent, the gratitude of the patient ox, will be fairly due to Mr. Hotchkiss. As yokes are generally made, it would seem that the same judgment had dictated their form which induced the Hibernian to declare that it was the nature of the beast to pull by the tail. This yoke is suspended and turns on pivots in a way which causes it to adapt itself perfectly to the

motions of the animal. The claim made, is to "the manner of combining the part which constitutes the collar, in the yoke described, with the branched yoke, or with the cross bars, by means of pivots, as set forth."

We have seen a yoke very nearly resembling this, described in a French work on agriculture; but the two are not identical.

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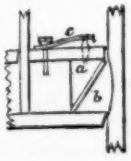
261. For an improvement in the mode of *Packing the Pistons of Steam Engines*; John Williamson, city of New York, August 31.

The piston is to have a cylindrical body, small enough to allow room for packing between it and the cylinder, plates of metal covering the upper and lower sides thereof, of such diameter as to fit the cylinder. Around the piston, between the two plates, there is to be a hoop of copper, the diameter of the upper edge of which is such as to extend to the cylinder, whilst its lower edge is in contact with the solid body of the piston, this hoop, therefore, being in the form of the frustrum of an inverted cone; it is cut through from bottom to top, to allow it to expand. A space *a*, will thus be left between the body of the piston and the copper hoop, and a space *b*, between the copper hoop and the cylinder, both of which spaces are to be packed in the ordinary way. Springs *c*, attached to the upper plate, press upon pins which communicate their bearing on to the packing in *a*.



The claim is to the combination of the conical hoop; the springs, packing rings, &c. with the other part of the piston, not being claimed as new.

The above arrangement does not appear to offer any thing superior to some other plans for giving elasticity to the packing of pistons.

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262. For a *Press for Hay, Cotton, &c.;* Jacob Grosvenor, city of New York, August 31.

In this press "the weight and accelerated gravity of a falling body are used to effect the compression of hay, cotton, hemp, or other similar substances. Such arrangement being used, when needful, in combination with a lever, in the form described, so as to diminish the length between the fulcrum and the working point of the lever, and thereby give an increase of power to the lever when the resistance is greatest." Such are the points claimed. A heavy follower, having a vertical rod extending to a considerable height above it, is to be raised by means similar to those used in raising the ram of a pile driver; and this is to be let fall upon the cotton, hay, &c. contained in a high vertical box; after which the follower is to be forced down by levers as indicated.

The idea of packing elastic fibrous material by means of a ram, is, we believe, new, and we also believe that it will be found to be worse than useless, as we do not entertain the slightest doubt that the time and power expended in raising the ram would effect twice as much in the process of packing in well known ways, as will be effected by the falling of the ram.

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263. For an improvement in the *Cooking Stove;* John S. Leavitt, Turner, Oxford county, Maine, August 31.

The claim is to "the combination and adoption of an open fire place with a cooking stove, having a furnace, oven, boilers, holes, &c. substantially as described:" which combination and arrangement differ sufficiently to sus-

tain the claim for a patent; but as to points of superiority, we have nothing to say, as the drawing and description do not render their existence very manifest.

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264. For *Manufacturing Hydraulic Cements;* Ebenezer C. Warner, city of Albany, New York. Patent dated October 6th, 1837. (See Specification.)

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265. For a *machine for Sowing and Spreading Lime, Plaster, &c.;* Levi Rice, West Chester, county of West Chester, Pennsylvania, August 31.

A circular, revolving table, or platform, is placed horizontally under the bed of a cart, at its rear end. It is made to revolve by a shaft connecting it with one of the driving wheels; a man in the cart, with a shovel, or otherwise, causes the article to be disseminated to pass through a hopper, or opening, upon the revolving table, whence it is thrown by the centrifugal force derived from its rapid motion.

The claim is to "the application of the centrifugal force to disseminate lime, plaster, &c. and small grain, in the manner described."

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266. For an improvement in the *Machine for separating Smut from Wheat;* and for cleaning all kinds of small grain; Benjamin M. Smith, Rochester, Monroe county, New York. Patent dated August 1st.

The claim is as follows: "what I claim as my invention is the constructing a machine for cleaning wheat, or other grain, having a shaft with revolving disks, the upper surfaces of which are made rough by punching, or otherwise; which disks are surrounded by a case, the interior of which is also made rough by punching, and the insertion of metallic points in alternate sections, the whole constructed as set forth; also the vanes as combined with this machine, and the particular manner of forming the step."

Specifications of American Patents.

Specification of a patent for the manufacture of a Substitute for Gum Senegal, to be used in calico printing, and other processes; granted to Walter Leversidge, *Dorchester, Norfolk county, Massachusetts. Patent dated May 30th,* 1837.

To all whom it may concern, be it known, that I, Walter Leversidge, of Dorchester, in the county of Norfolk, and State of Massachusetts, have invented certain new and useful materials, prepared by a process herein described, and also a new and useful composition of matter, to be used as a substitute for gum senegal, and other articles of a similar nature, employed in calico printing; which composition of matter, when prepared for the calico printer, I denominate "factitious gum senegal powder," and I do hereby declare that the following is a full and exact description of the mode of compounding and preparing the same; and also of preparing a substitute for gum senegal from certain individual materials used in making the compound.

The composition consists of sago, potato starch, and lime, which may be combined together in variable proportions, but the best mixture is made in

the following relative quantities, or nearly so. I take forty parts of sago, fifty-five parts of potato starch, and five parts of quick lime, which ingredients I mix together, and reduce the whole to a fine powder. I then put this powder into an open vessel, and expose it to a temperature not exceeding 220° of Fahrenheit's thermometer, keeping it at this temperature until it has parted with all the water which it will lose at that degree of heat, and until the mass has become slightly discoloured; to insure an equal action of the fire upon the mass, the vessel must be so constructed as that its contents may be stirred, or agitated, during the process of desiccation. The vessel is then to be closed, leaving only a small aperture through which the acid and other vapours may escape, and through which the powder may be examined by the aid of a small spatula, to ascertain the progress of the operation. The heat is to be gradually raised until it approaches a temperature of 620°; this part of the operation requiring from three and a half to four hours, or a length of time sufficient to produce the proper colour, which is a dark orange brown.

The vessel is then to be uncovered, and the contents mixed intimately by stirring; it is then to be closed, and a stopper put into the small hole left for the escape of the vapours, and the heat continued as before, but not increased in any sensible degree; a reaction of the materials now takes place, the mass becomes somewhat adhesive, and exhibits an appearance of partial fusion. This is ascertained by occasionally removing the stopper, or inserting the spatula, when a portion of the mass will adhere to it. It is now to be removed from the fire, spread out thinly on a floor, stirring and turning it until it becomes cool. After this it is again ground, and passed through a fine sieve, or bolting cloth. The material is then ready for the calico printer, and is used for the same purposes, and in the same way, as the native gum senegal.

I sometimes use the potato starch, without the admixture of sago, or of lime, and I likewise sometimes employ the sago alone, treating them in the same way with the above named compound, and by this means produce a material which, although not equally good for all purposes as a substitute for gum senegal, will answer in some cases, and has not, to the best of my knowledge and belief, been heretofore applied to this purpose.

What I claim as my invention, and wish to secure by Letters Patent, is the preparing a substitute for gum senegal or other gums of a similar nature, by the calcination or roasting, of a compound of sago, potato starch, and quick lime, either in the proportions designated, or in any other proportions by which a substance substantially the same is obtained.

I also claim the preparing of a substitute for gum senegal, or others, &c. in some respects analogous to the foregoing compound, by the calcination or roasting of either sago, or potato starch alone, or in variable proportions, with or without the addition of lime.

WALTER LEVERSIDGE.

Specification of a patent for an improved mode of protecting the Metallic Sheathing of Vessels; granted to EDWARD M. ROBINSON, *New Bedford, Bristol county, Massachusetts, August 8th*, 1837.

Be it known that I, Edward M. Robinson, of New Bedford, in the county of Bristol, and State of Massachusetts, have discovered a new and useful improvement in the art of preserving copper, or other metallic, sheathing, from corrosion and waste, when applied to the sides and bottoms of ships or

vessels; and I do hereby declare that the following is a full and exact description of my process.

Take of paint by grinding pure verdigris in linseed oil, and diluted to a proper consistence to be applied to the sheets of metal, with a mixture of one gallon of linseed oil, and half a pint of a lacker prepared as follows: viz. by boiling together seven and a half gallons of linseed oil, four pounds of shellac, four pounds of red lead, and four pounds litharge until the shellac is dissolved.

Apply this paint with a brush to both sides of the sheet of copper or other metal intended to be used, and when dry, add one or more coats as may be desired. If it is wished that the paint should dry very rapidly, half a pint of spirit of turpentine may be added to every gallon of oil used in diluting the paint. When the paint is perfectly dry and hard, the sheets may be fastened upon the vessel's bottom in the usual manner. This paint may also be applied to metallic sheathing after it has been placed upon the bottoms of vessels; and it may also be applied to but one side of the metal before being fastened upon the vessel's bottom; but it is decidedly preferable to use it as first described.

What I claim as my discovery in the art of protecting the copper, or other metallic, sheathing of vessels from corrosion, is that by the application of a coating of paint, in which verdigris is the principal ingredient, to such metallic sheathing, in the manner above described, such protection will be effectually attained. I do not claim to be the inventor, or discoverer, of the above described paint, nor do I intend to limit myself to its application in the form prescribed, but to use verdigris mixed with oil, or varnish, in any of the modes in which a desirable paint is produced, in which the main body consists of verdigris, limiting myself to its employment for the purpose of protecting the metallic sheathing of ships, or vessels; such application being as I firmly believe new in the arts.

EDWARD M. ROBINSON.

Specification of a Patent for the employment of the Mineral called Basanite, in manufacturing Hydraulic Cement; granted to EBENEZER C. WARNER, *City of Albany, State of New York. Patent dated Oct. 6th,* 1837.

To all whom it may concern: Be it known, that I, Ebenezer C. Warner, of the City of Albany, in the State of New York, have discovered a new and useful mode of manufacturing Hydraulic Cement by the employment of the mineral called Basanite, Lydian-stone, and commonly called touch-stone. And I do hereby declare that the following is a full and exact description of my discovery.

The said material is to be burned in any convenient mass, in the manner of burning lime in kilns, in layers of wood and pit coal, with the mineral on the top, to a red heat, which may be continued six or eight hours.

After cooling, the said mineral is to be cracked, and then reduced to a fine powder, as impalpable as practicable. For this purpose it should be ground between stones of the ordinary size and kind, or any other process of pulverizing may be resorted to, by which the material may be reduced. This powder is to be mixed with water to a proper consistence for application to the purpose for which it is designed.

The said hydraulic cement, thus prepared, is similar in its qualities, and appliable to the uses of Roman cement (so called,) and being insoluble and indis-

tructable in water, and capable of resisting the action of, and exposure to, frost; thus becoming a paste cement, or mortar, for laying stone which is to be exposed to the action of water; a cement for cisterns, aqueducts, and securing cellars, or other excavations, below the surface of the ground, which require to be secured against the admission of water.

The analysis of Lydian-stone as ordinarily found, is as follows:

Silex	23.
Alumine	15.
Potassa	8.
Lime	.50
Oxide of iron	18.
Copper	24.
Water, carbon and loss	11.50
	100

What I claim as my discovery, and desire to secure by letters patent is, a new and useful mode of manufacturing hydraulic cement by the employment of the mineral called Basanite, Lydian-stone, and sometimes touchstone, as a principal ingredient therein. EBENEZER C. WARNER.

English Patents.

Specification of a patent granted to FLETCHER WOOLLEY, *for his invention of improvements in the manufacture or preparation of materials to be used as a substitute for bees-wax, parts of which improvements are applicable to other purposes.* Nov. 11, 1837.

The various substances employed in the different processes of this invention are comprehended under the following heads, and will be referred to in describing such processes numerically.

First, all kinds of animal and vegetable fats and oils, solid at the medium temperature of the surrounding atmosphere, which is about sixty degrees of Fahrenheit, as tallow and other animal fats, and palm oil, cocoa-nut oil, and other like vegetable oils commonly used for giving light by, or in, combustion. Second, all kinds of animal and vegetable elains and oils, liquid at the medium temperature of the surrounding atmosphere, as the elain of tallow, palm oil, cocoa-nut oil, seal, whale, sperm, and other oils used for affording light by combustion. Third, all kinds of naphtha, or coal, tar, oil, caoutchouc naphtha, or caoutchouc oil, gas oil, vegetable naphtha, or vegetable tar naphtha, and any other like naphthas or oils used as aforesaid, and commonly sold for that purpose. Fourth, pyroligneous naphtha or ether, correctly named pyroxylic spirit, sulphuric ether, and all other spirits or ethers of like nature. Fifth, all mixtures of the substances included under head the third, with those substances included under head the fourth, as two parts of coal naphtha or caoutchouc naphtha, with about six more parts of pyroxylic spirit. Sixth, resinous bodies and resins, as caoutchouc resin, mastic, copal, shel-lac, and others, and combinations of them with each other, as one part resin and four parts shel-lac melted together. Seventh, mixtures of the substances included under the heads third, fourth, and fifth, with the substances included under head the sixth, as thick solutions of copal in spirits, ethers, or naphthas, &c., and caoutchouc in naphthas formed by processes already known to the public. Eighth, certain solid bodies

separated from solid animal and vegetable fats and oils, as stearine, stearic acid, margarine, and margaric acid, adipocere, and others of like nature. Ninth, mixtures of the substances included under head the second, with the substances included under heads third and fifth, or three parts of cocoa-nut elain to one of naphtha, or to two of the substances included under head the fifth.

Firstly, palm oil of commerce is to be put into a shallow vessel made of copper tinned, or iron or other suitable metals, and raised to the temperature at which incipient decomposition begins and vapour flies off, at which temperature it must be kept for upwards of half an hour, and then allowed to cool gradually and undisturbed; by which process the stearine will crystallize more perfectly, and separate better from the elain. When sufficiently cold and solid, or about the consistence of old honey, it is to be put into bags or wrappers made of strong linen or sacking, or other suitable material, of such size and in such quantity that each bag or wrapper when filled shall be about two feet long, one foot wide, and one and a half inches thick, and in this state subjected to the pressure of a powerful hydraulic screw, or other suitable press (a ten-inch hydraulic ram has been used.)

This pressure is to be increased very slowly and gradually, and the material kept as nearly as possible at the medium temperature of the surrounding atmosphere, as long as any elain continues to ooze, by which process the greater part of the elain will be pressed out from the stearine.

The elain thus obtained is applicable to the purposes of burning in lamps to give light, and of lubricating machinery; and the stearine thus produced may be made into candles or other useful articles, or manufactured into a substance to be used as a substitute for bees-wax, as hereinafter described.

Secondly, any of the substances included under head the first, are to be melted and mixed in the fluid state, with any of the substances included under the heads second, third, ninth, and fifth, in a suitable vessel, and in the proportions of three parts of the former to one of the substances under heads third, second, and ninth, or to thirty or forty parts of the substances included under head the fifth, or in any other suitable proportions determined by the dissolving strengths of the substances included under heads second, third, fifth, and ninth; and the solidity and less solubility of the substances included under head the first, for they must be mixed in such proportions that the mixture shall be nearly of the consistence of old honey, at the medium temperature of the atmosphere.

When thus mixed, the mixture must be allowed to cool gradually and undisturbed, to favour the more perfect crystallization of the stearine, and to facilitate the separation of the elain; and when cold, and of the consistence of old honey, or thereabouts, it must be put into bags or wrappers and subjected to pressure, as hereinbefore described; by which process the elain will be pressed out combined with its solvent, and the stearine will remain in bags or wrappers.

The stearine can be made into candles or other useful articles, or manufactured into a substance to be used as a substitute for bees-wax, as hereinafter described; and the elain combined with its solvents may be applied to the purposes of burning in lamps for giving light, and of lubricating machinery.

Thirdly, any of the substances included under head the eighth, of which those made from tallow are best, are to be melted and mixed in the fluid state with any of the substances included under heads sixth and seventh, also melted in a fluid state in the proportions of three parts of the former to one of the

latter, or in any other suitable proportions, accordingly as the resulting compound to be used as a substitute for bees-wax is required more or less tenacious. For the smaller the proportion of any of the substances included under head the eighth, the stronger or more tenacious is the compound of the substances included under head the sixth; resin melted with four times its weight of shel-lac is best adapted.

It will also be well to state here, that shel-lac will not melt and mix with the substances included under head the eighth, unless previously united with the resin, mastic, or such like resin; and also that caoutchouc, copal, &c., will not unite well with the substances included under head the eighth, unless previously dissolved, as mentioned and contained under head the seventh.

Fourthly, any of the substances included under the heads third, fourth, and fifth, are to be mixed with any of the substances included under the heads second and ninth, in proportions varying according to the dissolving strengths of the former, or the soluble qualities of the latter, for the purpose of rendering the latter more liquid and better adapted for burning in oil lamps of common construction for the purpose of affording light.

Fifthly, any of the substances included under head the fourth, are to be mixed with any of the substances included under head the third, particularly coal, tar, naphtha, and caoutchouc naphtha, in the proportions of one part of the latter to three of the former, for the purposes hereinbefore mentioned, and for burning in common oil lamps to give light.

Journ. Arts & Sciences.

Specification of a patent granted to W. HEMPEL AND H. BLUNDELL'S *for preparing animal and vegetable substances for manufacturing Candles.*

This invention consists in operating upon palm oil, animal fat, or tallow and bees wax, in the manner and with the materials hereinafter set forth and explained, so as effectually to separate the stearine from the elain contained in the palm oil and animal fat or tallow, and convert the said stearine, by submitting it to the process of oxygenation, bleaching, and purifying, hereinafter described, into a highly improved stearic acid, which used by itself makes a very superior candle, or mixed with bees-wax enables candles principally made of that material to be run in moulds, instead of being dipped and rolled in the ordinary tedious manner.

As to the palm oil, the patentees say they subject this material to seven different processes—crystallization, pressing, oxydation or conversion of the stearine into stearic acid, separating the stearic acid from the lime, washing and pressing a second time, bleaching and refining.

First, crystallization; palm oil, as imported, is melted and run into large iron or other vessels, which are called crystallizing vessels; in these it is allowed to cool very gradually, the stearine crystallizes at a temperature of about seventy-five degrees of Fahrenheit, and the elain at this temperature partly separates from it.

Second, pressing; at about the last-named temperature, it is subjected to a powerful hydraulic or other mechanical pressure; the liquid part which runs from the press is the elain, and the solid substance which remains in the press is the stearine in an impure state, with a portion of margarine.

Third, oxydation or conversion of the stearine and margarine into stearic and margaric acid. The stearine and margarine are first melted in an iron vessel; to every 104 lbs. of the stearine and margarine, add, very gradually,

12 lbs. more or less, according to the quality of the ingredients, of very dry hydrate of lime in a very fine powder, keeping the mass briskly stirred during the whole time. The temperature is to be gradually increased to about 240 degrees of heat, and kept well stirred for about three hours, or until a perfect combination of the stearine and margarine with the lime takes place. This may be known by the mass becoming thin and transparent, and when cold, assuming a glassy appearance. This operation being finished, the fire is withdrawn, and cold water added very gradually at first, stirring very briskly all the while, until the whole mass falls into a state of coarse granulation, or powder; this is then passed through a wire sieve, to break down any lumps that may remain.

The patentees observe, that it may be as well to state how they prepare the said hydrate of lime, although this forms no part of the invention claimed. The lime-stone must be of the best quality, and free from flints: take pieces of such lime well burnt and fresh, lay them on a sieve, and immerse the whole in water for the space of one minute; take it out, and let the water that is not absorbed run off; the lime will soon fall to a powder; take this and put it into an iron vessel moderately heated, and covered down with a wooden cover, to drive away, by evaporation, any water that is free. It must then be passed through a fine sieve, and used as quickly as possible, as it soon attracts fresh moisture.

Fourth, separate the stearic and margaric acid from the lime. The stearine and margarine, by the last described process, has now become acidified or oxygenated in combination with lime, forming stearate and margarate of lime. Now proceed to separate the stearic and margaric acid from the lime. For this purpose muriate of lime is used, and sulphuric acid; take as much of the muriate of lime as will produce sufficient muriatic acid to decompose the quantity of stearate and margarate operated upon. To the muriate of lime, add as much sulphuric acid as will precipitate the lime and set the muriatic acid free. Put to the stearate of lime a sufficient quantity of this muriatic acid to dissolve all the lime contained in it, taking care to employ an excess of acid; the proportion will be about 3 lbs. of muriatic acid diluted with 9 lbs. of water to 1 lb. of lime.

This mixture is to lay three or four days, in order to ensure the complete solution of the lime; sufficient heat is afterwards employed to melt the stearic and margaric acids which then float on the surface. The muriate of lime is removed into another vessel, and decomposed with sulphuric acid; the disengaged muriatic acid is used in the next operation with stearate of lime, and so on. By this process the only expense of acid is the sulphuric, which is a saving of at least 50 per cent., with an almost perfect separation of the lime from the stearic acid.

Fifth, washing and pressing a second time. The stearic and margaric acids having been well washed with hot water, are again subjected to the press at a temperature of about seventy-five degrees of heat, to separate the stearic from the margaric acid.

Sixth, bleaching process. The stearic acid is taken from the press, and put upon water in large shallow vessels, placed in the open air, and kept at the melting point from eight to twelve hours, occasionally stirred, and exposed as much as possible to the action of the atmosphere, until it has become white. The margaric acid is bleached in the same manner, as above described, in separate vessels.

Seventh, refining process. It is then warmed again and removed in a melting state to a vessel which is called an agitating tub. To every 1000 lbs.

of stearic acid we use in this refining process 1 lb. of the black oxide of manganese, prepared from the white carbonate of manganese, or about $2\frac{1}{2}$ lbs. more or less, of the common black oxide of manganese, 40 lbs. of concentrated sulphuric acid, diluted with 200 lbs. of pure water; this solution, while warm from the heat which it evolves, is placed in a suitable vessel above the agitating tub; the stearic acid, being at the melting point in the vessel below the agitator or stirring shaft of this last named vessel, is set to work, and the solution is allowed to run gradually into it, until the whole is well mixed, which generally requires about two hours. The mass is allowed to lay in this state for forty-eight hours; it may then be boiled by steam for two or three hours, when it will be found to be sufficiently refined. The sulphuric acid which is at the bottom is now run off, and the stearic acid which remains is well washed with pure water; it is then put into large conical vessels of stone ware, enclosed in a box or jacket and kept warm by steam heat, and lined with conical bags of suitable strong, filtering paper, through which, being warm, it finds its way; and when the stearic acid has been thus filtered, it is run into blocks, when it will be found a beautiful stearic acid, which the patentees call palm stearic acid, or palm wax. It is then ready to be made into candles in the usual way.

Another mode is also proposed to be employed as a process of refining. To 100 lbs. of stearic acid add 16 lbs. of sulphuric acid, diluted with about 128 lbs. of pure water, or 21 lbs. of sulphate of manganese, and 9 lbs. of common salt. Boil these by steam for ten or twelve hours; or take about 10 per cent. of phosphoric acid, highly concentrated, or 10 per cent. of oxalic acid; boil in either case ten or twelve hours with steam. By using the phosphoric or oxalic acid, any earthy or metallic matters that might still adhere to the stearic acid, are effectually dissolved with more certainty than can be done by the agitator, unless the stirring shaft is very carefully and vigorously worked. And there is no extra expense of acids, as it is worked over and over again, being occasionally purified by the addition of a small quantity of sulphuric acid, which throws down any earthy or metallic matter the phosphoric or oxalic acid may have collected. The stearic acid, after having been well washed with pure hot water, is in this case also filtered as above, and run into blocks.

As to animal fat or tallow, the patentees proceed to describe the processes for the preparation of stearic acid from animal fat or tallow by crystallization. The animal fat or tallow is well cleansed from all impurities in the ordinary way; it is then, in a melted state, put into a round vessel, in which is a stirrer or agitator, and in which it is worked until it has cooled down to about 100 degrees of heat, when it will assume a milky appearance, with a granulated texture; the granulations are the stearine in a state of crystallization.

In this state it is put into the press, and subjected to a powerful pressure; the liquid which runs from the press is the elain or oil of tallow; the solid substance is the tallow stearine, for making candles when operated upon as follows:

Oxydation, or conversion of stearine into stearic acid. This process is exactly the same as is described for palm stearine. Separation of the stearic acid from the lime. This process is also the same as is described for palm stearic acid. Crystallization and pressing a second time; after the stearic acid has been well washed with hot water, it is again crystallized or granulated as before described, and pressed a second time. Refining process; the stearic acid is taken from the press, and refined by the second process des-

cribed for refining palm stearic acid; after being well washed with pure hot water, it is filtered as described for palm stearic acid, and cast into blocks ready to make into candles. Thus has the substance become good stearic acid, which the patentee calls tallow stearic acid.

Another mode of carrying on the process with animal fat or tallow is as follows:—Having crystallized and pressed as before, the stearine obtained is to be saponified by combining it with the caustic leys of soda, potash, or any other alkali; thus making stearate of soda or potash, &c. This stearate of alkali is dissolved in a vessel with hot water and steam; to this must be added as much phosphoric acid as will neutralize the alkali and set the stearic acid free. The stearic acid is put into an evaporating vessel with a heat of 180 degrees, and is left until the whole of the water is evaporated; it is again pressed, and, after having been well washed and filtered, is cast into blocks, and ready to make into candles. The phosphate of the alkali, is decomposed with quick lime, forming phosphate of lime and caustic alkali; the caustic alkali is again employed to oxydize a fresh portion of stearine; the phosphate of lime is decomposed by sulphuric acid, and the phosphoric acid is ready to be again employed by this method; the only loss is the sulphuric acid and lime, being about 3 per cent. of the alkali and phosphoric acid.

As to common tallow, mix therewith margaric acid from palm oil, prepared and bleached as aforesaid, in the proportion of 10 to 20 lbs. of margaric acid to 100 lbs. of tallow in the manufacture of common mould, or dip candles.

As to bees-wax; we will lastly describe our method of operating upon this article, which is simply mixing with it a portion of our palm or tallow stearic acid in its highly improved state, in the proportions of from 5 to 10 parts of stearic acid to 100 parts of wax, and then proceeding to make candles of the materials so mixed, by running them into moulds in the ordinary manner of making other mould candles. Ibid.

Specification of a patent granted to Alexander *and* James Dixon, *for their improvements in dyeing, by the application of materials not hitherto so used.* April 29, 1837.

This invention is comprised in a small compass. The patentees say, according to the ordinary processes of dyeing browns, greens, olives, Saxon blues, and blacks, a substance called "argal" (crude tartar) is employed as a mordant, as is well understood by dyers, which is an expensive material. Now, the object of this invention is to employ sulphate of soda as a mordant in the process of dyeing, in place of argal, by which the process of dyeing will be materially improved, both as to the cost and in other particulars.

The sulphate of soda is to be ground and sifted, in order to obtain it in the state of fine powder, similar to the condition in which argal is prepared for the dyer; and the subsequent treatment of sulphate of soda is similar to that pursued in preparing and employing argal as a mordant; and a dyer, acquainted with the ordinary process of using argal will, by substituting sulphate of soda, find the working of this invention easy to be performed; and he will find, that, in many respects, the colours will be produced more readily than when argal is used, and hence the time occupied in the dyeing with some colours be shortened.

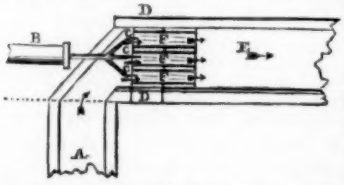
It should be remarked, that the sulphate of soda obtained from the nitrate of soda, is that which is most generally effective for the various colours above mentioned; but the sulphate of soda obtained from common salt (muriate of soda,) though less valuable, as requiring more observation and care of the dyer, may be advantageously employed for a mordant in dyeing heavy colours, particularly browns and greens. Ibid.

Specification of a patent for Improvements in the Manufacture of Carbonate of Soda; granted to FRANCIS GYBBON SPILSBURY *and* WILLIAM MAUGHAM. *Sealed Jan.* 11*th, and enrolled July* 11, 1837.

This invention relates, first, to a method of condensing the muriatic acid gas, which is now suffered to escape into the atmosphere with the smoke and vapour of the furnaces.

Secondly, to a method of obtaining carbonate of soda from muriate of soda without first producing a sulphate of soda, whereby the expensive and laborious processes of obtaining and decomposing that sulphate are avoided. It is well known that in order to condense the muriatic acid gas (which escapes so largely in that part of the process of making carbonate of soda, which consists in converting muriate of soda into sulphate of soda,) it is only necessary to bring the smoke and vapours, which issue from the reverberatory furnaces in converting muriate of soda into sulphate of soda, into contact with a sufficient body of water. But the smoke cannot be so treated without at the same time being cooled down, whereby the draft to the furnace is proportionably diminished. A high temperature is so necessary to the rapid and effective decomposition of muriate of soda by sulphuric acid, that manufacturers prefer occasionally paying damages for the nuisance they occasion to the neighbourhood, rather than to submit to the positive and daily loss which must be the consequence of any check to the draught of their decomposing furnaces; it is therefore desirable to render the draught of the furnace independent of the higher or lower temperature of the column of air contained in the chimney, a mode of accomplishing which constitutes the first part of our invention.

Description of the Drawing.—A, E, represents a section of the principal flue into which all the flues of the several decomposing furnaces of alkali work unite. It is bent at right angles, rising, as shewn, from beneath the surface of the earth. B, is a steam-pipe proceeding from a steam-boiler delivering steam of from ten to twenty pounds on the inch pressure. The pipe, B, separates into three branches, C, C, C, terminated by jets of about one-quarter of an inch aperture each. D, D, is a partition of brick or other suitable material which divides the flue, A, E, transversely. In this partition are firmly embedded three pipes, F, F, F, not exceeding four inches diameter, and about eighteen inches long, open at both ends. These pipes form the only communication whereby the smoke can pass from the part of the flue, A, to that marked E. The jets of the steam-pipes C, C, C, are inserted, as shewn, into the centre of the parallel, and opposite, open pipes, F, F, F; they enter about two inches, the smoke passing around them freely in its passage through F, F, F, in the direction of the arrows. The effect of this arrangement is that so soon as steam of from ten to fifteen



pounds on the inch is permitted to rush out of the jets, C, C, C, it communicates so great a velocity to the columns of air contained in the open pipes, F, F, F, that a most powerful draught is created in the flue, A, E, independent of any aid from the natural draught of the chimney. Although only three steam-jets and air-pipes are shown in the drawing, their number must be increased as the number of furnaces to be worked increases. The arrangement here described is sufficient for two large decomposing furnaces such as are ordinarily employed. Without exactly determining the number, which must depend upon circumstances peculiar to each manufactory, it may be generally stated, as a rule, that five air-pipes of four inch diameter, and five steam-jets of one-quarter of an inch aperture, projecting steam from ten to fifteen pounds pressure, will be found sufficient to work four large reverberatory furnaces more effectively than a chimney two hundred and fifty feet high. The end of the flue, E, is made to communicate with any form of condenser the manufacturer may choose, whereby the vapour and gas traversing the flue, may be brought into contact with a body of water sufficient to condense the aqueous vapour and absorb the acid, but as such condensation, and means for effecting the same, are well known, and as we do not claim any particular form, it is unnecessary to enter into a description thereof. After the smoke has been thus made to pass over the water, the uncondensable gases are to be carried into a chimney to escape in the ordinary way.

We will now describe our second improvement, which consists in a mode of producing carbonate of soda by converting muriate of soda into a fluoride of sodium or fluosilicate of soda (the latter is to be preferred as being the more insoluble,) instead of first obtaining a sulphate, as ordinarily performed in manufacturing carbonate of soda. For this purpose, concentrated fluoric acid, obtained from Derbyshire spar in any of the usual methods, and, as is well known, is to be mixed with its weight of muriate of soda, and so much water added as will prevent the muriatic acid from going off in the state of gas. There is then to be added sufficient ground flint, or other silicious matter, to convert the fluoride of sodium into fluosilicate of soda. The supernatant liquor, consisting of concentrated muriatic-acid holding a little fluosilicate of soda in solution, is then to be drained off. The remaining fluosilicate is then to be washed slightly with as little water as possible, after which it is to be transferred to a furnace, and subjected to a low red heat to drive off any adhering muriatic acid. The dry product is next to be mixed with double its weight of powdered chalk or limestone, and the whole boiled in water for several hours. The effect of this operation is a double decomposition, whereby the fluosilicate of soda and carbonate of lime are converted into fluosilicate of lime and carbonate and sesquicarbonate of soda, the latter being dissolved in the water. This supernatant liquor is to be drawn off, the residuum well washed, and the washings added to the first liquor, the whole is then to be evaporated to dryness, and the resulting product heated to redness. What remains is pure carbonate of soda, which may be redissolved in water and crystallized in the ordinary way. If instead of the fluosilicate of soda the fluoride of sodium is preferred, then the same process is to be gone through, with the omission of the ground flints, and the result will be fluoride of calcium and carbonate of soda.

Having thus described our invention, and the best means we are acquainted with for carrying the same into effect, we would remark in the first place as respects the condensation of the muriatic acid gas, we do not claim

any form of condenser, or any peculiar method of bringing the gas and smoke from the decomposing furnaces into contact with water; neither do we confine ourselves to the exact arrangements, herein described. But we claim, as the first part of our invention, the application of a jet or jets of steam playing into the flue or flues of the ordinary decomposing furnaces employed by alkali makers, for the purpose of impelling the column of vapour and gases contained within them, independent of, or in conjunction with, the ordinary draught of the chimney, when performing that part of the process of making carbonate of soda which consists in converting muriate of soda into sulphate of soda.

Secondly, we claim the treating of muriate of soda with fluosilicic acid in the manufacture of carbonate of soda, in place of converting muriate of soda into sulphate of soda, and then into carbonate of soda, as heretofore practised.

Reper. of Pat. Inven.

Specification of a patent for Smelting Iron with Anthracite Coal. Granted to GEORGE CRANE. *Sealed Sept.* 28, 1836, *enrolled March* 28, 1837.

According to the ordinary practice of obtaining iron from iron-stone, mine, or ore, in this country, the iron-stone, mine, or ore, either calcined or in the raw state according to its respective qualities is put into suitable furnaces, with coke produced from bituminous coal, formerly called pit-coal in contradistinction to charcoal produced from wood, which was the fuel employed in this country previous to the introduction of pit-coal, in the smelting and manufacture of iron. Now as there are districts in which are to be found large quantities of iron-stone, mine, or ore, in the immediate neighbourhood of what is known as stone-coal, or anthracite coal, it has long been considered as a desirable object to employ such coal for the smelting and manufacture of iron, and although attempts have been made to apply such description of coal in the smelting and manufacture of iron, the same have failed and have been abandoned. In addition to such advantages to be obtained from the using of anthracite or stone coal in the districts where such coal is found together with iron stone, mine, ore, from the practice I have had, I am induced to believe such coal from its properties, will be found to produce a quality of iron more nearly resembling iron obtained by the aid of vegetable charcoal. Now the object of my invention, is the application of such anthracite or stone coal, combined with a hot-air blast, in the smelting or manufacture of iron from iron-stone, mine, or ore. And in order to give the best information in my power for enabling a workman to carry out my invention, I will describe the process, or means, pursued by me, and in doing so, I will suppose the furnace of an ordinary construction to be in blast, and that the machinery and apparatus are adapted for the application of hot-air blast, as is well understood and extensively applied in many places where the ordinary fuel (coke of bituminous coal, or the coal in a raw state) is employed in the manufacture of iron from iron stone, mine, or ore, and I have found that a furnace having suitable apparatus for heating the blast to about 600 degrees of Fahrenheit, a good arrangement for carrying out my invention, though so high a degree of temperature is not indispensably necessary, but I believe preferable. In charging such a furnace, I throw in about 300 weight of anthracite or stone coal or culm, to each 500 weight of calcined argillaceous iron stone, with a proper quantity of flux as if working with the coke of bituminous coal, such charging of the furnace and the

general working, with the exception of the using of anthracite or stone coal, is to be pursued as if working with coke or bituminous coal, and I would remark that the quantities above given are such as I have hitherto employed in making the best qualities of pig-iron, videlicet, No. 1 or No. 2, at my works, from the anthracite, stone-coal, or culm, found in the neighbourhood of the Yniscedwyn Iron Works; but those quantities may be varied according to local circumstances, and the refractory nature of the iron-stone, mine, or ore, or otherwise to be reduced and the quality of iron desired to be obtained, as is the case in ordinary working, and at the judgment and discretion of the manager as heretofore. And I would remark that the anthracite or stone coal or culm, may be coked in like manner to bituminous coal before charging the furnace, but from my experience I have not (so far as my practice goes in working with the coal obtained in my neighbourhood) found that such coking is necessary, or that a more advantageous result is obtained than in applying the anthracite or stone-coal directly from the mine. And it is desirable to observe, I have found it of advantage that the blast of hot-air should be as free and unimpeded as possible, and from that account I have hitherto used only anthracite or stone coal, the smaller parts of which would not pass through a sieve of an inch mesh, but where the pillar or volume of blast is considerable, say two pounds and upwards on the square inch, this precaution is not necessary.

Having thus described the nature of my invention, and the manner of carrying the same into effect, I would have it understood that I do not claim the using of a hot-air blast separately, in the smelting and manufacture of iron as of my invention when uncombined with the application of anthracite or stone-coal and culm; nor do I claim the application of anthracite or stone-coal in the manufacture or smelting of iron, when uncombined with the using of hot-air blast. But what I do claim as my invention is the application of anthracite or stone-coal and culm, combined with the using of hot-air blast in the smelting and manufacture of iron, from iron-stone, mine, or ore, as above described.

Reper. Pat. Inventions.

Progress of Practical and Theoretical Mechanics and Chemistry.

Notice on the Bichromate of the Perchloride of Chrome. By M. Walters.

I have constantly succeeded in the preparation of this compound by employing the quantities and process following: I placed in a tubulated glass retort 100 parts of sea-salt dissolved, and 168 parts of neutral chromate of potash, the whole being well mixed and reduced to a very fine powder; I then fixed to the retort a tube, and a receiver with two apertures, and poured by degrees, through a tube, in the form of an S, which was fixed in the aperture of the retort, 300 parts of concentrated sulphuric acid.

The liquor thus obtained is of a beautiful blood-red colour; it is volatile and sends forth vapour copiously; when placed in contact with a quantity of water, it falls to the bottom in drops of an oily appearance, and changes into chlorhydric acid and chromic acid; its boiling point is fixed and takes place at 118° Cent. under the pressure of $0^{m}{\cdot}76$; its specific gravity at the temperature of 21° Cent. is 1.71; it attacks mercury with great activity; for this reason all contact with this metal must be avoided; it is decomposed by sulphur, detonates with phosphorus, dissolves chlorine and iodine,

and combines with ammonia with a disengagement of light. A small quantity mixed with concentrated alcohol combines with a violent explosion and the inflamed alcohol is scattered with force. This unexpected action very nearly deprived me of my sight, and has burnt me in a most dreadful manner.

The bichromate of the perchloride of chrome is composed according to my analyses, of

Chlorine,	.	45.14
Chrome,	.	35.58
Oxygen,	.	19.28

This result agrees with that obtained by H. Rose, and with a combination calculated according to the formula $2\ Cr\ O^3 + Cr\ O^6$.

$$Cr^3 = 1055.457 = 35.37$$
$$Ch^6 = 1327.950 = 44.51$$
$$O^6 = 600.000 = 20.12$$

The density of the vapour deduced from observation gives $D = 5.9$; the value obtained by calculation by means of the formula $2\ Cr\ O^3 + Cr\ Ch^6$, is equal to $D = 5.48$.

3 vol. of chrone	.	11.6433
6 vol. of chlorine	.	14.6760
6 vol. of oxygen	.	6.6156
		32,9349

$$\frac{32,9349}{6} = 5.48$$

The analysis and the density of the vapour of the bichromate of the perchloride of chrome coincide therefore in representing this body as a combination of chromic acid and perchloride of chrome; its constitution may however be regarded in a different light, which, without being in contradiction either to the composition or to the density found, explains, in a certain degree better its remarkable characters and its little stability. Dr. Thomson having subjected this body at the time to analysis, had already offered quite a peculiar opinion on its constitution; he regarded it as being formed of chromic acid and of chlorine, and called it *chloro-chromic* acid; but this opinion could not withstand the objection of H. Rose, that with this supposition the combination must contain 10 per cent. more chlorine than obtained by analysis. But if instead of representing this combination as formed of chromic acid and chlorine, we look upon it as being formed of $Cr\ O^2$ and chlorine, the hypothetical radical $Cr\ O^2$ of chromic acid (itself expressed by the formula $Cr\ O^2 + O$,) acting the part of a simple body similar to the oxide of carbon and to benzoyl, this combination becomes analogous to the chloro-oxicarbonic acid, the chlorine occupying the place of the oxygen, which is not found in the radical of chromic acid. We may therefore represent this body by the formula $Cr\ O^2 + Ch$, which agrees both with analysis and with the density found. Indeed the analysis calculated according to this formula gives the following result:

1 atom of chrome	351.819	= 35.37
2 atoms of chlorine	442.650	= 44.51
2 atoms of oxygen	200.000	= 20.12
	994.469	100.00

And as to what concerns the density, calculated according to the same formula, we find

1 vol. of chrome	3.8811
2 vol. of chlorine	4.2890
2 vol. of oxygen	2.2078
	10.9809

$$\frac{10.9809}{2} = 5.49$$

But here each atom of the compound represents only two volumes of vapour. This body may therefore be regarded as a distinct acid, which might be named *chloro-oxi-chromic acid.* Recollecting that the perchloride of chrome does not exist in an isolated state, that analogous compounds are only produced by acids, which for one atom of radical, contain three atoms of oxygen, which are isomorphous with each other, and which may all be expressed after the hypothesis of M. Persoz, by the formula $R O^2 + O$, in taking into consideration the facility with which this body is decomposed when brought into contact with other bodies, and its little stability; this manner of regarding the constitution of this body, which explains its various actions, offers the appearance of much probability.

Lond. and Edin. Philos. Mag.

Preparation of Bicarbonate of Potash. By Prof. WŒHLER.

Carbonate of potash, both in the dry state and in solution, combines very slowly with the second equivalent of carbonic acid to form the bicarbonate of potash. By means of charcoal in a finely divided state the combination may be made to take place very easily. It can be performed in the following manner: bitartrate of potash is to be heated in a covered crucible, the burnt mass to be moistened with water, put into a receiver, and carbonic acid passed through it. The absorption takes place with such rapidity that the mass becomes strongly heated, so much so that it is necessary to surround the receiver with cold water to prevent the reconversion of it into carbonate of potash. The saturation is complete when it ceases to give out heat. It is then dissolved in the smallest possible quantity of water at the temperature of 100° to 120° Fahr.; upon the cooling of the filtered solution, the greater part of the bicarbonate separates in fine crystals.—*Poggendorff's Annals.*

Lond. & Ed. Philos. Mag.

Preparation of Protoxide of Tin.

Owing to the great difficulty of preparing protoxide of tin according to the directions generally given in chemical works, I was led to make some experiments on the subject. I find the following process to be that which yields the purest oxide. Prepare a solution of protochloride of tin by dissolving the metal in hydrochloric acid, taking care always to have a great excess of the metal; the solution is then evaporated to dryness, together with a lump of tin to prevent the formation of perchloride. The tin is then separated, and the chloride weighed, and rubbed in a mortar with its equivalent, or rather more, of crystallized carbonate of soda; the mixture soon becomes fluid; it is then put into an evaporating dish and heated on the sand-bath, frequently stirring, till it becomes thoroughly black; it is then removed and well washed with boiling water, filtered, and dried at a gentle

heat on the sand-bath. The oxide thus prepared is of a beautiful blue-black or slate-colour; it is very soluble in hydrochloric acid, and when heated to dull redness in the air, it takes fire and burns, and is converted into peroxide.

S. A. Sandall.

St. Thomas' Hospital, January 3rd, 1838.

Ibid.

Efficacy of Lightning Rods, or Conductors. By F. Maceroni.

I perceive that a question is mooted at the meeting of the British Association for the Advancement of Science, whether in the case of a certain "monument 140 feet high, erected on the summit of a mountain 1,400 feet high, augmented safety, or danger, would be the consequence of attaching to it a conductor or paratonnere?" I am induced to call the attention of your intellectual readers to this passage, as I am very sure that the subject is of great importance to society. About six months ago (vol. xxvi. p. 367) you honoured me by giving insertion to my account of a safety gunpowder magazine, in which I speak of lightning conductors, and to which I would request your readers to refer. There is just now a gentleman, one Lieutenant Green, of the Royal Navy, who is endeavouring to convince the public by his writing, that conductors are prone to cause the damage they are intended to avert. I must say, that I regard this statement as a mischief, for I have seen too much of the saving power of conductors not to wish that every house in Great Britain were protected by one.

Lieutenant Green, in his anti-paratonnere pamphlet, lately published by Tanner, of New Bond street, tells us of fifty churches in this country having been lately struck by lightning, because they had metal vanes! To be sure;—but metal vanes are not conductors; and conductors should not be formed of a wire scarcely bigger than a bell wire. In my above quoted article, I have stated, that a tube is better for a conductor than a solid rod, because it is to the surface of bodies that electricity adheres. Nothing could be fitter for the purpose than iron gas pipes; but their connexions and attachments, down the building, must be of stone, or other non-conducting materials.

Previously to the church of St. Peter's, at Rome, being protected by numerous conductors, by the French government, damage was continually being done to the upper part of that stupendous edifice; but never was the least injury inflicted after the application.

It must be borne in mind, that an elevated and efficient conductor will give its protection more frequently in perfect silence, and unobserved, than by conducting into the ground, or water, a positive discharge of electric matter, accompanied by a flash and thunder. The many-pointed conductors will silently draw off the electricity from a passing cloud, without any discharge, properly so called, so that the blow has been parried, if it be not a *bull* to say so, before it is struck.

During my several sojourns at Rome, I have made particular inquiries into the effects of lightning on St. Peter's church. After the numerous substantial, many-pointed conductors were affixed to the summit, and most prominent angles, of the church, by the French in 1808, an electric discharge was not known to have fallen upon it more than three times, and then it did no injury. It appears that the clouds, in passing over the church, are deprived of their plus electricity by the conductors, just as a Leyden jar is silently equilibrized by the presentation of a metallic, pointed conductor. How many ships would be saved from damage, conflagration, and, perhaps,

instant submersion, by properly constructed vehicles for conveying the electric fluid over the sides into the water? What inconvenience could be felt, from a branched rod and a chain from the mast-head, hanging along the shrouds into the water! All the failures of conductors arise from their want of sufficient mass of metal. A zinc chain, or tube, would be far less liable to oxidation than iron; and, as I have before remarked in the case of a powder magazine, &c., the metal might easily be kept with a clear surface, by an occasional rubbing with a brick-bat. About London we see conductors not thicker than a quill, applied to shot towers, tall chimnies, &c., whereas they ought to be gas tubes of at least an inch in diameter. The top ought to be formed in the manner of a branch of a tree, with five or six points of copper gilt, the extreme points being of pure gold or silver, as are those at Rome.

In some volcanic districts, over which it would appear that the solidified crust of our globe, which covers the yet incandescent mass, is thinner or more porous, than at other points, the electrical exchange of compliments between the earth and atmosphere, are almost as frequently directed upwards from the earth to the clouds, as in the contrary direction. Even against such upward discharges, the conductors, inserted in the earth, and ascending to the summit of the building, will preserve them from injury. I have witnessed a great many instances of ascending streams of electricity, some of which I have remarked upon in your pages, particularly in Nos. 401 and 402; and I am induced to think that we should see many more exhibitions of the process, were it not for the trees which act as silent conductors, both upwards and downwards. Electricity is the real food of plants, which they absorb through the innumerable points of their leaves and branches. On the same principle should a lightning-conductor be constructed with as many points as convenient.

Lieutenant Green says, "seventy-nine churches in Great Britain have in a few years been struck; some of them destroyed; many, after being furnished with from one to four conductors. All of those struck had metal vanes." How "many," out of the seventy-nine churches, were furnished with conductors, this opponent to Benjamin Franklin, does not tell us. He only shows the danger of metal vanes inviting the lightning, without a conductor to take it away. A bit of wire attached to the walls by iron eye bolts, or staples, is certainly more likely to cause mischief than to give protection. A proper and elevated conductor will generally carry off the electricity silently, without any apparent discharge.*

Lond. Mech. Mag.

New Experiment on Galvanic or Chemical action.

The following experiment is communicated to "The Annals of Electricity, Magnetism and Chemistry, conducted by William Sturgeon," by a correspondent whose signature is L. B. W.

"I took a smooth and clean piece of zinc, about the size of a walnut, inserted it in a piece of bullock's gut, and having carefully squeezed out all the air from the gut, tied it tight at both ends. I then placed the zinc, so surrounded by the gut, (into which there could be no mechanical possibility of entrance to the fluid,) into a jar of dilute sulphuric acid, and left it so all night. In the morning I found the gut full of gas almost to bursting. To prove the nature of the gas I made a pin hole in the membrane,

* *Note.* The above article is inserted because the fact stated respecting St. Peter's Church is deemed important; it otherwise assumes as facts what requires to be verified. *Ed.*

and, squeezing the gas through the flame of a candle, found, as I expected, that it was hydrogen.*

Here there could have been no voltaic influence; for zinc *alone* can produce none. Chemical it could only have been by the transmission of the acid; but the gut contained none. The zinc bore the same clean appearance as when first inserted, and was nowise oxidated.

"I repeated the experiment again and again, with the same result, excepting only that I found the inside of the bladder, or gut, and the zinc slightly moistened with a tasteless vapid fluid." L. B. W.

To W. Sturgeon, Esq.
&c. &c. &c.

The interesting facts above stated, appear to admit of satisfactory explanation from experiments made by the Editor of the Journal, and published in the first number of his Annals. He ascertained that different points on the surface of the same piece of metal are evidently in different states of electric polarity, and act towards each other, where connected by imperfect conductors, like the poles of a voltaic battery, producing a decomposition of the interposed fluids. There can be little doubt, therefore, that the moisture supplied by the gut was decomposed by the voltaic action of the zinc itself, the oxygen of the moisture combining with the metal, while the hydrogen escaped and expanded the enclosing membrane.

G.

Progress of Civil Engineering.

Asphaltic Mastic.

The ancients were indebted for the preservation of their buildings to the choice of their materials, and particularly to the use of cements, which, perfectly uniting with metal, stone, or wood, rendered their structures firm and solid. Amongst others, the use of a bituminous cement appears to have been extensive from the earliest times. Historians inform us, and modern observation confirms their statements, that the bricks with which the walls of Babylon were constructed were cemented together with hot bitumen. And in the destruction of some ancient remains of fortifications, supposed to have been Roman, near Pyrimont, about forty years ago, the stones appear to have been similarly cemented; and so great was their tenacity, that the works were with great difficulty pulled down, and not without the use of gunpowder. This circumstance led to a singular and important discovery, for the fact of which, as follows, we are indebted to a gentleman named Perrigny, a native of that neighbourhood. During the removal of the above ancient

*That animal membrane (bladder gut) has not only a permeability to fluid, but a power, by capillary attraction, of raising it two or three feet above its level, I call to witness my friend Goldworthy Gurney, who lately related to me the following experiment. Fill a glass funnel with water, and tie a fresh bladder over the large opening so securely that no water can escape; place it, with the bladder downwards, in a vessel (large dish) also full of water. Into the nozzle, or small end, of the funnel, a tube of 3 feet in length is to be inserted and secured quite tight by luting; set the apparatus thus arranged aside, and watching it, it will be found, said my informer, that the water will soon begin to rise in the tube, and ultimately reach the height of two or three feet.

remains, it was observed that the cement bore a great resemblance to the asphaltic mass or mountain in the park of Pyrimont, about five miles north of Seyssel. This led several persons present to think of making a similar application of it; amongst others was a relative of M. Perrigny, whose dwelling on the banks of the Rhone was so very damp, that the lower part could not be appropriated to any use whatever. This person considered that its application might succeed in keeping out the wet, every other remedy that he had tried having failed. The experiment was, accordingly, made, and succeeded beyond his most sanguine expectations. This circumstance, among other early trials of its properties, speedily led to its very general adoption in that vicinity, where the working of this material has become of great importance, and where the presence of the bituminous asphalte is so great as to appear almost inexhaustible, and, although but recently worked to any great extent, yet its properties as a cement appear to have been long known. It already constitutes the chief wealth of the country, which was previously half wild.

In various parts of the eastern chain of the Jura mountains, there are bituminous veins of greater or less extent; but the only place at present known where the asphaltic rock is to be found is at Pyrimont, above named in the department de l'Ain. In this immediate vicinity is also obtained a peculiar kind of mineral pitch, there called bitumen, which, upon being mixed in certain proportions with the asphalte, forms the mastic, or cement, of which it is our business to treat, and which, in France, after years of struggling with prejudices, and the opposition of parties interested in its failure, is obtaining so large a share of patronage as to be extensively employed both in the public and private works of that kingdom.

For many years after the discovery of the valuable properties of the asphalte, the mine at Pyrimont was the property of a company of Swiss merchants; but, from their defects of management, and from the limited extent of their finances, their operations were confined within very narrow bounds; and, at length languishing, the properties of the mastic were likely to have become lost to society. It, however, passed into other hands, among whom we find the English name of Taylor, and also of Mr. Equem, a gentleman who has persevered against all opposition in calling the attention of the French engineers and architects to the subject; and having executed a variety of works with unvaried success, has secured for it a rapidly advancing popularity in France, where we have lately had an opportunity of professionally examining and acquainting ourselves, not only with its nature, but also with its manipulation.

The business has now fallen into the hands of a private company at Paris, who, with a capital of 30,000*l.*; purchased the mine at Pyrimont, and are carrying on an extensive trade in its manufacture, with Mr. Equem at the head of the executive department.

The asphaltic mastic of Seyssel, when prepared for use, is, as before observed, a compound of two mineral substances; one is the native asphlate, the other is bitumen; the proportion of the former in the amalgum is 93 centimes, and of the latter 7 centimes. The asphlate is extracted from the mine in blocks, and reduced to an almost impalpable powder before it is mixed with the bitumen. The latter, as extracted from the mine, is first broken into pieces of about the size of an egg,

these are put into boiling water, and the particles which rise to the surface are purified by boiling for 24 hours: the result is, the bitumen to be mixed with the pulverised asphlate. The combination of these two substances forms the mastic or cement, which being reduced to a fluid state by the application of caloric, is poured into moulds of any shape required; or, in this state, used as cement in hydraulic works, &c. The use of the bitumen appears to be the giving of ductility to the mastic; and, if a very minute quantity of sulphur be added, the mastic will become hard, and partially brittle.

In France, where, with the exception, we believe, of Belgium, this mastic has, at present, only been employed, attempts have been made to imitate it; but in these fictitious compounds substances have been introduced, instead of asphalte, which absorb from 40 to 50 per cent of bitumen, forming a composition which the heat of the sun will melt, and which cracks when exposed to the cold of winter. In other instances, matter has been substituted which, having no affinity whatever for bitumen, disintegrates with time. When in Paris, we had an opportunity of making a fair comparison between the genuine and the fictitious materials. In the abattoir of Montmartre, one of the great public slaughter-houses of Paris, a part has been laid down with the mastic of asphalte, and another part with the fictitious mastic, both as substitutes for flag-stone pavement. For this purpose, perhaps a more severe test of their respective merits could not have been found, being exposed to the tramping of men and cattle, the dying struggles of the latter, with the blood and water with which it is constantly deluged. The flag-stone pavement hitherto used required frequent repairs and renewal; yet so great are the tenacity and hardness of the genuine mastic, that, although it had been thus in use for many months, it appeared as if it was new; whilst, on the other hand, the fictitious mastic had worn so much in holes as very much to resemble a honeycomb; and these holes being filled with blood and filth, presented to an unaccustomed eye a very disagreeable sight.

The genuine mastic possesses the hardness of stone, and yet preserves a certain elasticity. When used as pavement for terraces or footpaths, it appears to resist the wear equally well with granite; and, when prepared in the manner now adopted in Paris, it is difficult to distinguish it in such situations from that stone. One of the finest specimens of paving that ever came under our notice, and which, at first sight, we mistook for granite, is that on the north side of the palace and gardens of the Tuilleries: it is about 1100 yards in length, and 10 ft. wide; it is composed of the asphaltic mastic; and the joints, which transversely cross it the whole breadth, and which at present appear to divide the pavement into a number of large, equally sized slabs, are disappearing, by the mastic becoming more dense from the tramping of feet; so that this extensive piece of pavement will soon appear, from end to end, like one immense sheet of stone.

A few minutes after the mastic has been spread in a fluid state, it again takes its natural density, which is such, that, at the heat of 30° Reaumur (equal to 100° of Fahrenheit,) it resists all impressions from an ordinary force. Its extensive application to the covering of buildings, instead of tiles, slate, or lead, has induced the trial of experiments in France, by which it was ascertained that it is anti-electric, a property which it is desirable that all bodies should possess that are employed in roofing.

Its application, also, for the flooring of halls, passages, and apartments is no way dangerous on account of fire, as it is not inflammable, the quantity of pitch which it contains being so very small. For the floors of underground kitchens, &c., it is particularly applicable, it being warm, and keeping out all damp, as well as vermin and insects, which are frequently so abundant in such places. When employed in the construction of water tanks or reservoirs, it imparts neither taste, smell nor colour, to the water it contains. Arch. Mag.

On the Valuation of the Mechanical Effect of Gradients on a Line of Railroads. By Peter Barlow, Esq., F. R. S.

The exact amount of the influence of ascents and descents occurring in the line of railway, on the motion of a load drawn by a locomotive engine, having been differently estimated by different persons, the author was induced to investigate the subject. A few observations are premised on the erroneous assumptions which, he conceives, have in general vitiated the results hitherto deduced. The first of these is that the expenditure of power requisite for motion is equal to the resistance to inaction; whereas, it must always greatly exceed it. No account, he remarks, has been taken of the pressure of the atmosphere on the piston, which the force of the steam has to overcome before it can be available as a moving power. Another source of error has been that the statical and the dynamical effects of friction have been confounded together; whereas, they are the same in amount, only when the body is put in motion by gravity, but not when it is urged down an inclined plane by an extraneous force. In the latter case, these effects are no longer comparable; friction being a force which, in an infinitely small time, is proportional to the velocity, while that of gravity is constant at all velocities; or, in other words, the retardation from friction is proportional to the space described, while that from gravity has reference only to the time of acting, whatever space the body may pass over in that time. It is an error, to assume that the mechanical power of the plane is equivalent to a reduction of so much friction; for the friction down the inclined plane is the same as on a horizontal plane of the same length, rejecting the trifling difference of pressure; and the whole retardation in passing over the plane, or the whole force required to overcome it, is the same at all velocities, and by whatever force the motion is produced; but the assisting force from gravity is quite independent of the space, or of the velocity.

In the investigations which the author has presented in this paper, he assumes that equal quantities of steam are produced in the same time at all velocities; and he adopts for his other data, those given by Mr. Pambour in his Treatise of Locomotive Engines; he deduces a formula from which, the speed on a level being given, we may compute the relative and absolute times of a train ascending a plane; and consequently, also, the ratio of the forces expended in the two cases; or the length of an equivalent horizontal plane; that is, of one which will require the same time and power to be passed over by the locomotive engines as the ascending plane.

The next objects of enquiry relate to the descent of trains on an

inclined plane, and comprise two cases; the first, that when the power of the engine is continued without abatement, and the second, that when the steam is wholly excluded, and the train is urged in its descent by gravity alone. The author arrives at the conclusion, that in the first of these cases, when the declivity is one in 139, the velocity, on becoming uniform, will be double that in a horizontal plane; and that for a declivity of one in 695, the uniform velocity of descent will be one-fifth greater than on the horizontal plane; and this he observes, is perhaps the greatest additional velocity which it would be prudent to admit. A plane of one in 695 is therefore the steepest declivity that ought to be descended with the steam-valve fully open; all planes with a declivity between this and that of one in 139, require to have the admission of steam regulated so as to modify the speed, and adjust it to considerations of safety; and lastly, all planes of a greater slope than this last, require, in descending them, the application of the brake. Lond. Mech. Mag.

Defacing Public Buildings and other Objects.

In France and Italy, so strong is the admiration for public gardens, for statuary, and other works of art, that they may be exposed to the public for years together, without getting in the slightest degree defaced or destroyed; whereas in Great Britain every public edifice, monument, or iron railing, is more or less injured. If a gentleman, in the neighbourhood of a town give the public the privilege of walking through his grounds, he may expect to find the borders trod upon, and flowers plucked up, perhaps by the root, his trees cut or torn down, and every thing more or less destroyed. In one of the public gardens in a town on the Continent, a nightingale built its nest and hatched its young inside a bush, within reach of the public walk. A footman, servant to an English family resident there, observing the nest, seized it and carried it off. So strong was the indignation of the populace, who caught the offender in the act, that he was brought before a magistrate, and condemned to be drummed out of the city, with a label on his breast, intimating his crime; which was executed amid the hootings of the populace. Whatever virtues the people of Great Britain possess, they have yet to learn the practical principle, "Look at every thing, and touch nothing." We know of nothing that will operate as a cure, so powerfully as the establishment of schools for infant and juvenile training; and we appeal to facts in proof of this position.—*Stow's Training System.* Arch. Mag.

Railway Speculators.

Some extraordinary evidence was given, it is said, before one of the Parliamentary committees, as to the means used to obtain the amount of subscriptions required by the standing orders of the House of Commons. A Jew, whose name bore a resemblance to that of a great capitalist, signed his name for 25,000*l.* This individual had neither house nor lodging: he received 4*l.* for signing the deed. Persons were employed to procure signatures, who received 5*s.* for each, giving four to the signer, and keeping one for themselves. The names of the clerks were put down for 500 shares each. One man's name appears for 32,000*l.*, and another for 20,000*l.* A news-agent signed for 10,000*l.*, and his son for 3000*l.*, and one of the solicitors for 1000 shares. One of the secretaries to the company procured signatures to the extent of 215,000*l.*; another to the extent of 86,000*l.*; and a

third to the amount of 260,000*l.* Several of the directors, whose names stood for 10,000*l.* each, caused the figures to be altered to 20,000*l.*, on the day before the deed was sent to be deposited in the proper office.—*Observ.*

Min. Jour.

Important improvement in Beams for Building.

A beam of very extensive dimensions, without pillar or prop, has been erected at the Pottery Gas Works, across the whole span of the new retort house, which is fifty feet. There are few objects, perhaps, connected with mechanism more worthy of inspection as a matter of curiosity, or a proof of the stupendous power of mechanical skill and contrivance. Hitherto the plan for erecting beams has been without recourse to the aid of mechanism, but in this beam there is brought to a practical result the whole power and ability that the materials are capable of, at a great saving of expense. The whole is fire-proof, supporting an iron roof of twenty tons, whilst the beam itself weighs only two tons. It is made upon Witty and Co.'s patent principle. We are informed that two such beams as this would be quite sufficient to support a bridge of fifty feet span. We have often thought that a very great saving might be made in bridge building by something of this kind, whereby objects which usually cost thousands might be accomplished for as many hundreds. We would recommend this invention strongly to the notice of railway companies; for it appears to exhibit the very thing wanting in viaducts for railways, and would cost but a tithe of the expense of those massive structures. No proof can be more convincing as to its practicability and application to viaducts than this beam and roof.—*North Staffordshire Mercury.*

Farm. Mag.

Progress of Physical Science.

On the Cause, the Prevention, and the Cure of Cataract. By Sir David Brewster.

Having submitted to the Physical Section of the British Association an account of a singular change of structure produced by the action of distilled water upon the crystalline lens after death, Sir D. Brewster was desirous of communicating to the Medical Section some views which this, and previous observations, have led him to entertain respecting the cause, the prevention, and the cure of cataract, he makes the following observations.

The change of structure to which I have referred consists in the development of a negative polarizing band or ring between the two positive rings nearest the centre of the lens; the gradual encroachment of this new structure upon the original polarizing structure of the lens; and the final bursting of the lens after it had swelled to almost a globular form by the absorption of distilled water.

As the crystalline lens floats in its capsule, there can be no doubt that it is nourished by the absorption of the water and albumen of the aqueous humour, and that its healthy condition must depend on the relative proportion of these ingredients. When the water is in excess, the lens will grow soft, and may even burst by its over absorption; and when the supply of water is too scanty, the lens will, as it were, dry and indurate; the fibres and laminæ, formerly in optical contact, will separate, and the light being reflected at their surfaces, the lens will necessarily exhibit that white opacity which constitutes the common cataract.

This defect in the healthy secretion of the aqueous humour, as well as the disposition of the lens to soften or to indurate by the excess or defect of water, may occur at any period of life, and may arise from the general state of health of the patient; but it is most likely to occur between the ages of 40 and 60, when the lens is known to experience that change in its condition which requires the use of spectacles. At this period the eye requires to be carefully watched, and to be used with great caution; and if any symptoms appear of a separation of the fibres or laminæ, those means should be adopted which, by improving the general health, are most likely to restore the aqueous humour to its usual state. Nothing is more easy than to determine at any time the sound state of the crystalline lens; and by the examination of a small luminous image placed at a distance, and the interposition of minute apertures and minute opake bodies of a spherical form, it is easy to ascertain the exact point of the crystalline where the fibres and laminæ have begun to separate, and to observe, from day to day, whether the disease is gaining ground, or disappearing.

In so far as I know, cataract in its early stages, when it may be stopped or cured, has never been studied by medical men; and even when it is discovered, and exhibits itself in white opacity, the oculist does not attempt to reunite the separating fibres, but waits with patience till the lens is ready to be couched or extracted.

Considering cataract, therefore, as a disease which arises from the unhealthy secretion of the aqueous humour, I have no hesitation in saying that it may be resisted in its early stages, and in proof of this I may adduce the case of my own eye, in which the disease had made considerable progress. One evening I happened to fix my eye on a very bright light, and was surprised to see round the flame a series of brightly coloured prismatic images, arranged symmetrically, and in reference to the septa to which the fibres of the lens are related. This phenomenon alarmed me greatly, as I had observed the very same images in looking through the lenses of animals partially indurated, and in which the fibres had begun to separate. These images became more distinct from day to day, and lines of white light, of an irregular triangular form, afterwards made their appearance. By stopping out the bad parts of the lens, by interposing a small opake body sufficient to prevent the light from falling upon it, the vision became perfect, and by placing an aperture of the same size in the same position, so as to make the light fall only on the diseased part of the lens, the vision entirely failed.

Being now quite aware of the nature and locality of the disease, though no opacity had taken place so as to appear externally, I paid the greatest attention to diet and regimen, and abstained from reading at night, and all exposure of the eyes to fatigue, or strong lights. These precautions did not at first produce any decided change in the optical appearances occasioned by the disease; but in about eight months from its commencement I saw the coloured images and the luminous streaks disappear in a moment, indicating, in the most unequivocal manner, that the vacant space between the fibres or laminæ had been filled up with a fluid substance transmitted through the capsule from the aqueous humour. These changes took place at that period of life when the eye undergoes that change of condition which requires the use of glasses, and I have no doubt that the incipient separation of the laminæ would have terminated in confirmed cataract had it not been observed in time, and its progress arrested by the means already mentioned. Since that time, the eye, though exposed to the hardest work, has preserved its strength, and is now as serviceable as it had ever been.

If the cataract had made greater progress, and resisted the simple treatment which was employed, I should not have hesitated to puncture the cornea, in the expectation of changing the condition of the aqueous humour by its evacuation, or even of injecting distilled water, or an albuminous solution, into the aqueous cavity.

On Electrical Induction. By MICHAEL FARRADAY, Esq., D. C. L., F. R. S., &c.

The object of this paper is to establish two general principles relating to the theory of electricity, which appear to be of great importance; first, that induction is in all cases the result of the actions of contiguous particles; and secondly, that different insulators have different inductive capacities.

The class of phenomena usually arranged under the head of *induction* are reducible to a general fact, the existence of which we may recognise in all electrical phenomena whatsoever; and they involve the operation of a principle having all the characters of a first, essential and fundamental law. The discovery which he had already made of the law by which electrolytes refuse to yield their elements to a current when in the solid state, though they give them forth freely when liquid, suggested to the author the extension of analogous explanations with regard to inductive action, and the possible reduction of many dissimilar phenomena to one single comprehensive law. As the whole effect upon the electrolyte appeared to be an action of the particles when thrown into a peculiar polarized state, he was led to suspect that common induction itself is in all cases an *action of contiguous particles*, and that electrical action at a distance, which is what is meant by the term induction, never occurs except through the intermediate agency of intervening matter. He considered that a test of the correctness of his views might be obtained by tracing the course of inductive action; for if it were found to be exerted in curved lines it would naturally indicate the action of contiguous particles, and would scarcely be compatible with action at a distance. Moreover, if induction be an action of contiguous particles, and likewise the first step in electrolyzation,* there seemed reason to expect some particular relation of this action to the different kinds of matter through which it was exerted; that is, something equivalent to a specific electric induction for different bodies; and the existence of such specific powers would be an irrefragable proof of the dependence of induction on the intervening particles. The failure of all attempts to produce an absolute charge of electricity of one species alone, independent of the other, first impressed on the author the conviction that induction is the result of actions among the individual and contiguous particles of matter, having both forces developed to an extent exactly equal in each particle.

The author describes various experiments, with the view of showing that no case ever occurs in which an absolute charge of one species of electricity can be given. His first experiments were conducted on a very large scale: an insulated cube, twelve feet on the side, consisting of a wooden frame, with wire net-work, every part of which was brought into good metallic contact by bands of tin foil, had a glass tube, containing a wire in connexion with a large electrical machine, passed through its side, so that about four feet of the tube entered within the cube and two feet remained

* Chemical decomposition by the electric current,—G.

without; but it was found impossible, in any way, within this apparatus, to charge the air with the least portion of either electricity.

For investigating the question whether induction is an action of contiguous particles, and for deciding that of specific inductive capacity, the author employed, in conjunction with the torsion balance of Coulomb with certain variations and additions (such as an electrometer,) a new apparatus, constructed for the express purpose. This apparatus consisted of two hollow brass spheres, of very unequal diameters, the smaller placed within the larger, and concentric with it; the interval between the two being the space through which the induction was to be effected. The apparatus had a tube in the lower part, furnished with a stop-cock, by means of which it might be connected with an air-pump, or filled with any required gas. In place of the lower hemispherical shell of air, occupying the interval between the two spheres, any solid dielectric, of the same form, such as shell-lac, glass, or sulphur, might be substituted. Two of these instruments, precisely similar in every respect, were constructed, and the author ascertained that the inductive power was the same in both, by alternately charging each, and dividing the charge with the other, and finding that, in all cases, the charge remaining in the one, and also that received by the other, was very nearly half the original charge.

The experiments on which the author principally relies, in support of the correctness of his views relative to induction being exerted in curved lines, are the following: a brass ball being laid on the top of an excited cylinder of shell-lac placed perpendicularly, the charge which a carrier ball received when brought to different points near to the brass sphere, was measured by means of the electrometer, and it was inferred, from the characters of the electricity, that the charge was one by induction, and, from its measure, that it proceeded in curved lines. By substituting for the brass sphere a disc of metal, above the shell-lac cylinder, it was found that when the carrier ball was brought near to the middle of the disc no charge was communicated, although a sensible one was obtained at the edge of the disc, and also at a point above its centre, further removed from the excited cylinder. Corresponding, and very striking, results were obtained when a brass hemisphere was placed on the top of the cylinder of lac. The charge communicated at the centre of the hemisphere was only one third of that obtained at the edge of its periphery; but by taking it at a point at some height above the centre, and consequently much further removed from the inducing cause, the charge was nearly equal to that of the periphery. Here, the author remarks, the induction fairly turned a corner, exhibiting both the curved lines or courses of its action, when disturbed from their rectilineal form by the shape, position and condition of the metallic hemisphere, and also a lateral tension, so to speak, of these lines on one another; all depending on induction being an action of the contiguous particles of the dielectric thrown into a state of polarity and tension, and mutually related by their forces in all directions. In the foregoing experiments the dielectric was air, but they were afterwards varied by substituting a fluid, as oil of turpentine, and likewise a few solid dielectrics, namely, shell-lac, sulphur, carbonate and borate of lead, flint-glass, and spermaceti; and with these, corresponding results were obtained. These results, the author considers, cannot but be admitted as arguments against the received theory of induction, and in favour of that which he has put forth.

In the course of these experimental researches, some effects due to conduction, which had not been anticipated, and which were similar to the

residual charge in the Leyden jar, had been obtained with such bodies as glass, lac, sulphur, &c. If the inductive apparatus, fitted with a hemispherical cup of shell-lac, after having remained charged for fifteen or twenty minutes, was suddenly and perfectly discharged, and then left to itself, it would gradually recover a very sensible charge; the electricity which thus returned from an apparently latent to a sensible state, being always of the same kind as that given by the charge. This return charge is attributed to an actual penetration, by conduction of the charge, to some distance within the dielectric at each of its two surfaces, and several experiments are adduced in support of this view. With shell-lac and spermaceti the return charge was considerable; with glass and sulphur, it was much less; but with air, no decided effect of the kind could be obtained. As this was an effect which might interfere with the results, in the method the author adopted for deciding the question of specific inductive capacity, and as time was requisite for this penetration of the charge, its influence on these results was guarded against, by allowing, between the successive operations, as little time as possible for this peculiar action to arise.

The author thus states the question of specific inductive capacity which he had proposed to investigate:—I suppose A an electrified plate of metal suspended in the air, and B and C two exactly similar plates, placed parallel to, and on each side of, A, at equal distances, and un-insulated; A will then induce equally towards B and C. If in this position of the plates, some other dielectric than air, as shell-lac, be introduced between A and C, will the induction between them remain the same? or will the relation of C and B to A be altered by the difference of the dielectrics interposed between them?

The experiments of Coulomb, from which it appeared that a wire surrounded by shell-lac took exactly the same quantity of electricity from a charged body, as the same body took in air, seemed to the author to be no proof of the truth of the assumption, that, under such variation of the circumstances as he had supposed, no change would occur. Entertaining these doubts of the conclusions deducible from Coulomb's result, he had the apparatus previously described constructed, as being well adapted for this investigation. After rejecting glass, resin, wax, naphtha, oil of turpentine, and other substances, as unfit for the purpose in view, he chose shell-lac as the substance best calculated to serve as an experimental test of the question.

For the purpose of comparing the inductive capacities of shell-lac and air, a hemispherical cup of shell-lac was introduced into the lower hemisphere of one of the inductive instruments, so as to nearly fill the lower half of the space between the two spheres; and their charges were divided in the manner already described; each apparatus being used in turn to receive the first charge, before its division with the other. As the two instruments were known to have equal inductive powers when air was contained in both, any deficiencies resulting from the introduction of the shell-lac would show a peculiar action in it, and if unequivocally referable to a specific inductive influence, would establish the point in question.

The air apparatus being charged, and its disposable charge being 290°, this charge was divided between the two. After the division the charge in the lac apparatus was 113°, and in the air apparatus 114°. From this it appears, that whilst, by the division, the induction through the air lost 176°, that through lac gained only 113°. Assuming that this difference depends entirely on the greater facility possessed by shell-lac of allowing or causing

inductive action through its substance than that possessed by air, then the capacity for electric induction would be inversely as the respective loss and gain; and assuming the capacity of the air apparatus as unity, that of the shell-lac apparatus would be $\frac{176}{113}$ or 1.55.

When the shell-lac apparatus was first charged, and then the charge divided with the air apparatus, it appeared that the lac apparatus, in communicating a charge of 118°, only lost a charge of 86°. This result gives 1.37 as the capacity of the lac apparatus.

Both these results, the author considers, require a correction; the former being in excess, the latter in defect. Applying this correction, they become 1.50 and 1.47. From a mean of these and several similar experiments, it is inferred that the inductive capacity of the apparatus having the hemisphere of lac is to that with air as 1.50 to 1.

As the lac only occupied one half of the apparatus containing it, the other half being filled with air, it would follow from the foregoing result, that the inductive capacity of shell-lac is to that of air as 2 to 1.

From all these experiments and from the constancy of their results the author deems the conclusion irresistable, that shell-lac does exhibit a case of *specific inductive capacity.*

Similar experiments with flint-glass gave its capacity 1.76 times that of air. Using in like manner a hemisphere of sulphur, it appeared that the inductive capacity of that substance was rather above 2.24 times that of air, and the author considers this result with sulphur as one of the most unexceptionable.

With liquids, as oil of turpentine and naphtha, although the results are not inconsistent with the belief that these liquids have a greater specific inductive capacity than air, yet the author does not consider the proofs as perfectly conclusive.

A most interesting class of substances, in relation to specific inductive capacity, the gases or aeriform bodies, next came under the author's review.

With atmospheric air, and likewise with pure oxygen, change of density was found to occasion no change in the inductive capacity. Nor was any change produced, either by an increase of temperature or by a variation in the hygrometric state.

The details are then given of a very elaborate series of experiments with atmospheric air, oxygen, hydrogen, nitrogen, muriatic acid, carbonic acid, sulphurous acid, sulphuretted hydrogen, and other gases, undertaken with the view of comparing one with another under a great variety of modifications.

In conclusion, the author remarks, "Thus induction appears to be essentially an action of contiguous particles, through the intermediation of which the electric force originating or appearing at a certain place, is propagated to or sustained at a distance, appearing there as a force of the same kind and exactly equal in amount, but opposite in its direction and tendencies. Induction requires no sensible thickness in the conductors which may be used to limit its extent, for an uninsulated leaf of gold may be made very highly positive on one surface, and as highly negative on the other, while the induction continues without the least interference of the two states. But with regard to dielectrics, or insulating media, the results are very different; for their thickness has an immediate and important influence on the degree of induction. As to their quality, though all gases and vapours are alike, what-

ever be their state, amongst solid bodies, and between them and gases, there are differences which prove the existence of specific inductive capacities."

The author also refers to a transverse force with which the direct inductive force is accompanied. The experimental proof of the existence of such a force, in all cases of induction, is, from its bearing on the phenomena of electro-magnetism and magneto-electricity, of the highest importance, and we cannot but look forward with the greatest interest to the promised communication in which these and other phenomena relating to this subject will be reviewed.

Lon. & Ed. Philos. Mag.

Effect of Cultivation upon Climate.

The question of the tendency of cultivation, and more especially the clearing of forests, upon the temperature of countries, has been much discussed, but without those definite results, which a subject of so much interest naturally claims. Until meteorological statistics shall be more diligently and accurately preserved, which there is reason to believe will be the consequence of an increasingly enlightened and expanding system of legislation, this question will not be solved with the desired precision. No country in the world, is more favourable to its accurate solution than our own. In one respect, the means are at hand of throwing much light on this subject,—namely—whether, within the observation of the settlers of our new countries, there has been any diminution or increase of the level of the water of lakes and ponds, and the quantity which flows in rivers which can be ascribed only to the effect of clearing and cultivation.

In a memoir on this subject by M. Baussingault, a translation of which appears in Jameson's Edinburgh Journal, Jan. 1838, facts are detailed from which the author draws the following conclusions:—

1st. "That the extensive clearing of a country diminishes the quantity of running water which flows over its surface; 2dly, that it is impossible for us to determine, at present, whether this diminution is owing to a smaller annual quantity of rain, or to an increased evaporation of the surface-water; or to those two causes combined; 3dly, that the quantity of running water does not appear to have varied in countries which have not been subjected to any changes arising from the progress of cultivation; 4thly, that, independent of the preservation of surface water, forests husband and regulate their flow; 5thly, that cultivation, when established in an arid country, which is not covered with forests, dissipates a portion of its running streams; 6thly, that, in clearings which are purely local, springs may disappear, without there being any ground to conclude that the annual quantity of rain has diminished; and 7thly, that drawing our conclusions from the meteorological facts collected in equinoxial regions, we may presume that the extensive clearing of a country diminishes the annual quantity of rain which falls upon it."

M. Baussingault enjoyed extensive opportunities of observations in South America as well as in Europe. No traveller since the time of Humboldt, has turned to a better account such opportunities in connexion with the resources of science. He cites the following, among other cases.

"Oviedo,* who, towards the end of the fifteenth century, so often tra-

*His Historia de la Provincia de Venezula, was published in 1823.

versed the valley of Aragua, positively affirms that New Valencia was founded in 1555, at the distance of half a league from the lake of Tacarigua; and M. de Humboldt found, in the year 1800, that the town was more than three miles (2700 toises) distant from its banks. The aspect of the district exhibits additional evidence of a great change. The rising grounds, which are somewhat elevated above the plain, maintain to the present day the name of islands, which at a former period, was most accurately assigned to them, seeing they were surrounded with water. The space which has been exposed by the retreat of the waters has been transformed into most fertile fields for the cultivation of cotton, sugar-cane, and the banana tree. These buildings which were reared in the immediate vicinity of the water are seen to be more and more forsaken by it. New islands made their appearance in the year 1796. An important military post in the shape of a fortress, which was built in 1740 in the island of *Cabrera*, is now situated on a peninsula. Lastly, in two islands of granite, those, namely, of Cura and of Cabo-Blanco, M. de Humboldt discovered, among the bramble bushes, several yards above the level of the water, deposits of fine sand, containing many *helicites*. Facts which are so speaking as these, and withal so well ascertained, could scarcely fail of exciting the ingenuity of the learned on the spot, in the way of supplying explanations of the remarkable change; and they all agreed thus far, that some subterranean conduit had been opened up, which allowed the waters to flow freely to the ocean. M. de Humboldt, when on the spot, paid all due regard to this supposition, and after an accurate examination of the localities, came very decidedly to the conclusion, that the cause of the diminution of the waters of the lake of Tacarigua was nothing more than the extensive clearing away of the woods, over the whole valley, during the course of the former half century. "In laying low the trees," he observes, "which covered the tops and flanks of the mountains, mankind, in all climates, are, at one and the same time, entailing two great calamities upon succeeding generations; they are producing a scarcity both of wood and water."

Since the time of Oviedo, who, like all the older chronologists, is perfectly silent concerning any subsidence of the water of the lake, the cultivation of indigo, sugar, cotton, and cocoa, had been carried to a great extent. In the year 1800 the valley of Aragua maintained a population as dense as that of any of the most populous portions of France. The smiling prosperity which existed in the numerous villages which teemed with its industrious population, could not be witnessed without the greatest satisfaction. Such was the prosperous condition of this charming country when M. de Humboldt was sojourning in La Hacienda de Cura.

After a lapse of twenty-two years, it was my lot afresh to visit the valley of Aragua. I fixed my residence in the small town of Maracay. I soon found that, for many years, the inhabitants had been remarking not only that the waters of the lake had ceased to subside, but, on the other hand, they affirmed they were very decidedly rising. The lands which had been formerly occupied in the cultivation of cotton were now submerged. The islands of Las Nuevas Aparecidas, which had risen above water in the year 1796, had now become shallows, which were dangerous for navigation. The tongue of land near to Cabrera, at the northern side of the valley, was now so narrow, that the smallest rise in the lake altogether inundated it; and a steady breeze from the north-

west was sufficient to submerge the road which led from Maracay to Nueva Valencia.

The fears, which for so long a time had annoyed the inhabitants on its banks, were now altogether changed in their character; and they no longer dreaded the entire disappearance of the lake. They were now anxiously considering if these successive invasions of the rising waters were about to overwhelm their properties; and those who had explained the previous diminution, by the existence of subterranean canals were convinced that they were now choked up, and that nothing would save them but opening the conduits afresh.

During the two-and-twenty years which had intervened, important political transactions had occurred. Venezuela now no longer belonged to Spain. The smiling valley of Aragua had been the arena of the most bloody contests, and war and death had desolated those happy scenes, and greatly reduced the population. On the first cry of independence, a number of slaves obtained their liberty by fighting under the standard of the new republic. Its wide spreading cultivation was neglected; the forest trees, so luxuriant within the tropics, had again in a great measure usurped dominion over that region, which its inhabitants, after a century of constant and painful labour, had reclaimed. During the growing prosperity of the valley of Aragua, the numerous streams which fed the lake had been arrested and employed in innumerable irrigations, and their beds were found dry for more than six months of the year. At the last epoch to which I have alluded, the streams being no longer so diverted flowed without interruption. Thus, then, during the progress and continuance of agricultural industry in the valley of Aragua, when the process of clearing was pushed farther and farther, and when cultivation in every shape was advancing, the level of the water gradually subsided. More lately, on the contrary, during a period of misfortune, and, we would fain hope, but temporary, when the clearing was no longer continued, and the cultivated lands have fallen back into their wild state, the waters having ceased to fall, and are now very speedily assuming a decided rising movement.

I shall now direct my remarks to another quarter, without however leaving America, in which we find a climate analogous to that of Europe, and where we traverse immense districts producing the most valuable grains. I shall direct attention to the higher lands of New Grenada, and to those elevated valleys, from 6000 to 9000 feet above the level of the sea, which enjoy, throughout the year, a temperature of from 58° to 62° Fahr. Lakes are frequent among the Cordilleras; I might easily dwell upon many of these, but shall bring under review only those which have been the subject of previous observations.

The village of Ubata is placed in the vicinity of two lakes. It is an important fact that, sixty years ago, these two sheets of water formed one only. The older inhabitants have observed the waters gradually diminish, and their shores extend themselves year after year. Fields of corn, of the greatest fertility, at the present time cover districts which thirty years ago were completely covered with water. The falling of the mean level of this lake will the more readily be credited by the consideration, that an occasional fall of three or four inches lays bare a great extent of surface. If we inquire in the neighbourhood of Ubata of any of the old men, who in their younger days were devoted to the chase, or if we examine the records of any of the different parishes,

no doubt will remain that numerous forests have been felled. The clearing still goes on; and it is equally certain that the retreat of the water has not ceased, though it does not advance so rapidly as it was wont to do.

It is hoped that such of the readers of the Journal of the Institute, as may have the means of obtaining correct information on a question of this nature, in the interior and particularly in the more elevated regions of the United States, will not neglect the opportunities they enjoy, and that the facts which they obtain, may be given to the public in that, or some other, Journal, so as to serve the purpose of accumulating evidence in relation to the meteorology of our country. G.

Meteorological Observations.

Although the hope was expressed in the Journal of the Institute, that all those Societies, Academies and Colleges which are provided with the instruments necessary in a series of meteorological observations, would advert to the interesting and important proposition of Sir John Herschel, of collecting the results of simultaneous observations from all parts of the world, (see Journ. Frankl. Inst. for Sept. last, p. 190, et seq.) and that they will be willing to use a little exertion, to comply with so reasonable and judicious a request, I have not yet had the pleasure of knowing that such observations were made during the late equinox, at any place in this vicinity, or State*. There may not have been time yet for the reception of any of the registers made in conformity to these suggestions; but it is hoped that they will be forthcoming. As an evidence of the interest which men of the highest rank in science (and it would be difficult to name one which stands higher than the proposer himself,) take in the progress of meteorology, I extract a portion of a lecture given by Professor Airy, (the present Astronomer Royal) at Neath on the 9th of September last, while on a tour in Wales. It was delivered by request, at the opening of the Scientific Institution in that town, and is replete with the most sensible remarks on the objects and duties which may most profitably engage the attention of such an Institution. G.

"Among the subjects of scientific observation to which the attention of persons in this neighbourhood may be called, is the general department of meteorology. Though much has been done in regard to observation, yet so little has been made out to place it in the rank of a science, properly so called (by the establishment of rules of any kind deduced from past phenomena, and which may be expected to hold in future ones) that I have great difficulty in pointing out any distinct course in which the efforts of persons willing to pursue this subject may be most advantageously directed. But there can be little doubt that regular observations of the barometer, thermometer, dew-point, actinometer, anemometer, electrometer, and rain-guage, would contribute to the establishment of empirical laws regarding the succession of phenomena at this place; and that the institution of observations simultaneous with those at other places would assist in determining the relations of the

* The only Register, in conformity to this plan, which I have noticed in the American Journals, is that contained in the Mathematical Journal, of the Flushing Institute, Long Island.

weather at different places depending on their respective localities, or the progress of a state of weather from one place to another. With reference to this matter, I would most strenuously recommend (even if all others be omitted) the making of observations at every hour during a day and a half at each of the solstices and equinoxes, in conformity with the plan sanctioned by Sir John Herschel. As to the classifications of, and deductions from, meteorological observations, I have no general rule to give, except that such classification be always made with reference to some preconceived theory or rule of some kind. If it does not appear that any irregularity follows, steadily, the conceived rule, some new one must be sought: but if an irregularity depending on this rule be detected, it will be best to subtract from every observation the corresponding amount of this irregularity, and then to examine the remainders with the view of discovering new laws of irregularity. For instance, if it should be found that, upon combining all the barometrical observations made at the same hours of different days, there was upon the whole a certain irregularity depending on the hour of the day, this might be subtracted from the observed heights, and the heights thus connected might be treated as if they had been so observed: if then, upon combining all at the same seasons of different years, an irregularity should be found, depending on the time of year, this might be subtracted: in like manner, if irregularities could be found depending on the moon's age, the moon's declination, the moon's distance from perigee, &c., these might be successively subtracted: and if after all these deductions there should be found a distinct relation between the height of the barometer and the state of the wind on the same day, or the day before, or the day after, a great step would have been made. But I mention these points merely as instances of the way in which I think it will be absolutely necessary to proceed.

"A class of observations, implying small expense and no great trouble, is the observation of the direction of the magnetic needle at intervals of five minutes throughout certain days, in conformity with the plan recommended by Gauss and Humboldt, and now acted on from the west of continental Europe to the east of Asia. It is known to you that the direction of the needle varies from year to year, from day to day, and from morning to afternoon; but it has also been found that it is subject to incessant irregularities from one minute to the next. In particular it has been remarked, that, when an Aurora Borealis was visible at one place, very great disturbances of the needle have been noticed at many other widely separated places in which the Aurora could not be seen. From the concurrence of the observations, as far as they have yet proceeded, this conclusion has been deduced: that the irregularities at very distant parts of the earth are strictly simultaneous in time, depending apparently not upon the time of day, or any other circumstance which distinguishes one place from another, but arising from some unknown causes which Humboldt aptly terms 'magnetic storms.' But are these storms universal? The observations of Glamorganshire may assist to determine this point.* And if so, what are they? Do they influence the weather, the state of health, or any other circumstance immediately affecting our bodily comforts? I know nothing which impresses the imagination more strongly than to find that we are surrounded by an agent, which, in the shape of

* A variation needle has, since the delivery of this address, been mounted at Neath.

magnetism is almost unperceived, but in the state of galvanism or lightning may be most powerful; and to know that even in its weakest state it is the part of a great system whose arbitrary laws are felt, with certainty and regularity, in its most distant region. It is like finding ourselves under the quiet espionage of a mighty government, whose motives of action we know not, but whose universality of power we feel most sensibly.

"For giving the due efficiency to the various labours of the members of the Institution, it will at some time be necessary to publish Transactions. Let it not be supposed that the Transactions of local societies are of small value, or unrespected in the world. The memoirs of the Manchester society may be cited as among the most valuable collections of local information and general science which we possess. The expense of such works in a cheap form, need not to be very great. Min. Rev.

On the increase of Temperature in the interior of the Earth.

M. Arago has lately communicated to the Academy of Sciences the result ofthe thermometrical observations which he made, on the first of May last, in the well which is now being sunk at the slaughter-house (Abattoir) of Grenelle. The boring has now reached the depth of 1312 English feet. The bed of chalk, in which they have for so long been engaged, is not yet traversed, but the numerous flints, which were unceasingly met with at lesser depths, have now disappeared. The city of Paris has determined that the boring shall continue to the depth of 2295 English feet, if the spouting water be not found sooner. It is presumed that the water which will issue from so great a depth will possess a temperature of between 93°2 and 95° Fahr., and, in that case, it might be employed for hot baths, &c. But however this may be, we shall now adduce the thermometrical observations which have been made at the depth of 1312 English feet. On the 29th of April, at 7 P. M., four instruments were sent down, viz. two of M. Bunten's self registering thermometers, one a *diversement* thermometer which M. Magus of Berlin had recently sent to M. Dulong, and another of the same construction manufactured by M. Walferdin. The two first were contained in a copper tube, in which they were secure from the pressure of the water; the third was open at the top, but in such a manner that the pressure could not alter its form; and the fourth was enclosed in a glass tube, which was hermetically sealed. These four instruments, after having remained for about thirty-six hours in the well or bore, were removed from it on the first of May about 7 A. M.; they then indicated the following temperatures:—

The first thermometrographe of M. Buten,	74°.3
The second, do.	74°.21
M. Magus' thermometer, á diversement,	74°.30
M. Walferdin's do.	74°.66

Assuming, then, 74°.3 Fahr. as the temperature at the depth of 1312 English feet, if you subtract from this number that of 51°.08 Fahr., which indicates the mean temperature of the surface of the earth at Paris, 23°.22 will remain for the increase of temperature, corresponding to 1312 English feet of depth, or, what comes to the same thing, 1°.8 Fah. for 101.2 English feet. If we take the case of the observatory as

the starting point for the temperature where it is at 53°.06 Fah., 21°.24 Fah. will then be given as the augmentation for 1222.5 English feet which corresponds to 103.348 English feet for each centigrade degree.

Mechanics' Register.

Russian Gold Mines.—Important Discovery.

The St. Petersburgh letters are much occupied with a discovery relative to the working of the Russian gold mines, which, if truly stated, may come to have some influence on the circulation of the precious metals. A letter of the 26th ult., says, "There has been found out, it is said, in the Ural Mountains, a new mode of extracting gold from the earth, sand, or ore. The sand, or earth, has been put into a blast furnace and melted, and the most extraordinary results obtained. By washing, the method hitherto pursued in Russia, one and a half zolotnicks of gold were produced, from 100 poods of sand, &c. the expenses were about covered; two zolotnicks per 100 poods were worth working. Fine sand, or earth, rarely produced more than three zolotnicks, and five zolotnicks were quite uncommon. By the new process, on 100 poods of melted sand, they obtained sixty zolotnicks in some cases; in others, forty to fifty zelotnicks, and on melting 100 poods of previously washed sand, they got forty to fifty zolotnicks, of gold. There is little doubt of the accuracy of these statements, but what the comparative expense of the two modes is I cannot tell you, nor whether the Ural grows sufficient wood for fuel, and whether coal can be found there. One pound Russian contains ninety-six zolotnicks; 100 poods are about 3,550lb. English weight."

The Editor of the Mining Journals adds:

The importance to be attached to the new process. by smelting, of extracting gold from the ores, or deposits, in the Ural Mountains, is so considerable, from the increased quantity obtained, as will be observed by reference to a paragraph, extracted from the columns of a contemporary, and inserted in our present number, that we are induced to direct the particular attention of our readers to the subject, while it will be our province to endeavor to obtain more detailed information of the plan adopted. The vast outlay of capital in Brazil, where attention has been directed to the gold districts, and the numerous veins which are found in Virginia and in the neighbourhood of Charlotte, in the United States, renders the subject one deserving of the first consideration. The process of smelting, as applied to gold ores, is not novel in theory, although we believe the present to be the first instance of its successful practical adaptation; and, if we are to credit the statement that the produce has been raised from five to fifty, or ten times the amount obtained, merely by the introduction of an improved mode of reduction, while the halvans, or refuse, have been found to contain a large produce, it is an epoch in mining, which will tend much to revive the spirits of the shareholders in the "Union Gold Mining Company," and others of a similar nature, and proves that this peculiar department of mining is in its infancy. We expressed our opinion at the time of the announced failure of the success of the "Union Gold Mines," that an improved mode, or one perfect in itself, so far as improvements then had taken place, would doubtless have yielded profitable returns, and we sincerely

trust, that the present discovery will be found applicable to the ores of America, which, however, are, if we mistake not, of a different character to those of the Russian possessions.

We have here, then, an additional evidence of the affinity and importance of science being combined with practice—of the association and the advantages derived from the application of chemistry to the operation of the miner; and hence further proof of the advantages which may be fairly calculated upon from the establishment of a "School of Mines."

New process for Extracting Gold.

To the Editor of the Mining Journal.

Sir:—The following information respecting the extraction of gold in the Russian dominions, I have lately received from an intelligent and well-instructed officer of mines in the Emperor's service, and as you are properly anxious to be informed on the subject, I send it to you:—

"Knowing very well the deep interest you take in all scientific discoveries, especially in the mining and metallurgical departments, I thought it might be agreeable to you to be informed of a new discovery made in the Uralian Mountains, in the method of extracting gold from the alluvial deposits. In the official letter received in Paris, I learned that the following curious comparative experiments were made in the extracting of the gold from the sand, by Mr. Anossott:—

1. "By the common method of washing used in all countries having gold (stream-work.)

1. "By the amalgamation—the method similar to that employed in Hungary in gold mines.

2. "By the damp way, or dissolving the sand in acids.

4. "By melting the sand in the blast furnaces.

"Those experiments were made by the order of the Minister of Finance, Comte Kancrin, to the end of ascertaining the exact quantity of gold contained in a given quantity of sand, and extracting the gold from the very middle of the grains.

"By the second method; they obtained eight times more gold than by the first (common system.)

"The third method produced four times more gold than the first; but by the fourth method, that is to say, by melting the sand, twenty-four times more gold was obtained than by the washing system.

"In that process, the produce of the melting is an alloy of cast iron and gold (fonte aurifere,) from which the gold is separated by means of sulphuric acid. By putting this last method into practice, we shall obtain yearly 8000 poods (sixty-two poods equal to one ton) of gold instead of 400, from the same quantity of alluvial deposit. But the conservatory principle, applied to the national wealth of the Government adopts the plan of only a moderate increase of the annual produce of gold, and securing thus a longer existence to the alluvial deposits."

The statement as to the difference produced by the modes of treatment may appear startling at first, but it may be considered as more probable if we take into account the nature of the substance in which the gold is enveloped. The produce of smelting, we see, is an alloy of cast-iron and gold, indicating that, as is very usual, the substance accompanying this gold is iron. Now, to say nothing of the very imper-

fect results which can be obtained by the old method of washing, if we consider the ingenious application of amalgamation which is mentioned, we shall at once perceive, that every particle of gold which is wrapt up in iron must infallibly escape the action of the mercury, and it is not difficult to imagine, that a very considerable proportion may be so defended. Let the whole, however be reduced by fusion, and all the metallic part will then be brought together and separated at once from the earthy part, and consequently, little or none of the gold can escape. Thus, we may account for a very considerable difference in the results of the processes that have been employed. The separation of the gold from the iron by sulphuric acid, is not likely to produce any waste of the precious metal.

It is anticipated, I know, that this improvement may be extended to other gold-producing countries, and I have no doubt but it may in due time; but it should be recollected, that smelting is a very expensive and tedious process in some of these countries, partly from scarcity of fuel, and partly from very imperfect methods for producing the necessary blast, by which it happens that the degree of heat required is difficult to obtain. Improvements may be made so as to remedy some of these defects, and one important one, I believe, would be, the application of the hot air blast; but those who know what the difficulties are in making alterations in established processes in some of the countries to which these observations are applicable, will see that considerable time may be required to accomplish the object, and the selection of very judicious and well instructed agents to carry the necessary measures into operation.

To any one who may be considering the subject with a view to adopting the use of this discovery, I would also suggest, that the chemical separation of the metals, is an operation which must be directed by one possessed of considerable skill and experience, and that it can only be done where sulphuric acid, or substances not easily transported, can be supplied in sufficient quantities. If the alloy be rich enough to bear the charge of carriage it might be better to send it to places where the requisite skill and materials can be had with facility, but here again, the fiscal regulations of different countries may oppose an obstacle.

I merely throw out these hints that persons who may wish to avail themselves of the advantages held out by this process, may be prepared to meet the difficulties that present themselves, and to set about the undertaking in a manner most likely to ensure success.

I am, Sir, your obedient servant,

Chatham place, July 6. JOHN TAYLOR.

Smith's Ever-pointed Stone-Cutting Chisel.

The ordinary chisels used for dressing and cutting stone very frequently want sharpening, which is an operation requiring time, judgment, and expense; having, when blunted, to be forged and sharpened, and afterwards hardened and tempered. A machine maker of the name of Smith in this town has lately invented an ever-pointed chisel, which will I think soon be generally adopted, provided it be made cheap. It is in fact an application of the principle upon which Messrs. Mordan's

(or rather Mr. Hawkins') ever-pointed pencil is constructed. A thin plate of well tempered steel, of the width of the chisel required, is placed between two cheeks of iron, and held tightly between them by means which I shall describe. The point of the thin steel projecting beyond the ends of the iron cheeks, forms the cutting edge of the chisel; and as soon as the edge which projects is worn away by the friction of the planing stone, the steel is advanced between the cheeks, and the edge is thus immediately renewed. To prevent the steel plate from slipping side-ways, there are studs on each side of it, on one of the iron cheeks, which go into corresponding holes in the other cheek. The whole is held together by a collar or mortise slipping over, and hammered up tightly, the cheeks being of a wedge shape. When the mortise, or collar, is driven properly home, a groove therein coincides with a groove in the cheek of the chisel, and a wedge being put into the hole thus formed, holds the whole chisel tight, and prevents the mortise from being shaken off by the blows of the mallet.

At the top of each cheek, on the inside, is the half worm of a screw; between these, a screw is inserted, the end of which touches the top of the steel plate, and on being turned down with a screw-driver, or otherwise, forces the steel out from between the cheeks for renewing the working edge.

I hope I have described the thing clearly enough to be understood by my brother masons and your readers, without the aid of a drawing; my hands are too rough and stiff with handling the mallet and chisel, and moving our hard native stone, to attempt the draughtsman.

I am, Sir, yours respectfully,

A Stonemason.

Bradford, Yorkshire, Nov. 28, 1837. Mech. Mag.

British Enterprise Abroad.

The traces of British capital are to be met with everywhere abroad. Most of the cities of Europe which enjoy the "new light" of the nineteenth century are furnished with it by "The British Continental Gas-Association," and Paris itself is about to be supplied with water on the English plan, by a Company of which the shares are in a great measure held by Englishmen. A "Sardinian Mining Company" has recently been established, for the purpose of working a number of mines in the Savoy, which are said to be exceedingly rich, and to offer very peculiar advantages. The proprietors are English, and they propose to smelt the ore by a new English process. The whole of the mines, of silver, copper, and iron, in the Duchy of Nassau, have been leased to an English association, who expect to reap important advantages from the application of a greater degree of skill and capital to the works than has ever hitherto been bestowed upon them. It is said that the total number of mines in the possession of this Company is upwards of two hundred and eighty! Ibid.

Manufactures of Lancashire.

Probably the largest entire room for manufacture in this county, and if so, in Europe, is that of Messrs. T. and E. Grundy, at Heap Bridge, near Bury. It is appropriated to the manufacture of wollens, and is 85 yards in length by 75 in width, and 12 feet in height; is supported by 253 pillars, some of which also bear gearing; it has 65 large windows, and 253 skylights; 672 feet of steam piping run through it; about 2,688 feet of shafting are at work. It contains, or will contain, eight carding engines, probably the largest in this county; eight gigantic slubbing frames; 40 mules; 200 looms, some for weaving prials, three in width; 450 gas jets; will be worked by one engine of comparatively small power, and is surmounted by a funnel of 69 yards and two feet.—*Bolton Free Press.*

Mech. Mag.

Flint in Wheat.

The scoundrels who burn wheatstacks in the country leave behind them some curious chemical results. "Swing" is a grand experimentalist. There are found in the embers lumps of coarse glass, which are the result of the fusion of the silicia, or flint, which wheat straw in particular is found to contain in very considerably quantities.

Min. Jour.

Iron.

The quantity of iron made in this country during the year 1836, has been estimated at the enormous quantity of a millon tons; the average price of pig-iron for the year being about 7*l.* per ton, and that of bar-iron about 11*l.* per ton.

Ibid.

LUNAR OCCULTATIONS FOR PHILADELPHIA, AUGUST 1838.

Angles reckoned to the right or westward round the circle, as seen in an inverting telescope.
☞ For direct vision add 180° ☜

Day.	H'r.	Min.	Star's name.	Mag.	from Moon's North point.	from Moon's Vertex.
3	9	3	Im. p Sagittarii	,6,	137°	119°
3	10	7	Em.		241	235
14	13	37	N. App. ☽ & C Tauri North 3′, 9	4, 5, ☽		
24	1	10	Im. α Virginis,	,1,	51	25
24	2	32	Em.		227	220

The meteorological table for this number, not having been received from our correspondent, the publication of it is necessarily postponed until the next number.

INDEX.

AMERICAN PATENTS, LIST OF, WITH EDITOR'S REMARKS, &c.

			PAGE.
	April, 1837.		
1.	White lead,	Peregrine Philips,	41
2.	Smoke stacks, flues, &c.	James Stimpson,	42
3.	Tongues of power loom shuttles,	Comfort B. Sharp,	43
4.	Hand rake, for hay, &c.	Stephen Coates,	ib.
5.	Cramping leather, for boots,	Jesse Van Winkle,	ib.
6.	Propelling boats,	John Finlay,	44
7.	Standing press,	Joel Barns,	ib.
8.	Rail-roads	Uri Emmons,	ib
9.	Fire arms,	Elijah Fisher,	ib.
10.	Loom for coach lace,	Erastus B. Bigelow,	45
11.	Smelting iron,	George E. Sellers,	ib.
12.	Washing iron ore, &c.	Frederick Fredly,	46
13.	Blast Furnaces,	John Barker,	ib.
14.	Hat bodies,	Hugh Moore,	ib.
15.	Frunace for shear steel,	Simeon Broadmeadow,	ib.
16.	Smelting iron,	Simeon Broadmeadow,	47
17.	House lamp,	Samuel Rust,	ib
18.	Rotary steam engine,	Roger M. Sherman,	ib.
19.	Cradle for cutting hemp,	Wilson A. Larimore,	48
20.	Measuring garments,	William C. Bishop.	ib.
21.	Cotton gin,	Alexander Jones,	ib.
22.	Inserting corset rings,	Jonathan S. Turner,	ib.
23.	Fire arms,	Daniel Leavitt,	49
24.	Fire arms,	John W. Cochran,	ib.
25.	Fire arms,	John W. Cochran,	ib.
26.	Spoke shave,	Ira. L. Beckwith,	50
27.	Rules for carpenters, &c.	Lemuel Hedge,	ib.
28.	Spring Saddles,	Moses Baldwin,	ib.
29.	Loom,	Christian W. Schonherr,	ib.
	May, 1837.		
1.	Rail-roads, turning table for	Jeremiah Myers,	108
2.	Iron chest,	Benjamin Sherwood,	109
3.	Stone facing, &c.	David Hull and John Critcherson	ib.
4.	Granite, &c. cutting, &c.	John D. Buzzell,	110
5.	Air pump for steam engines,	Thomas B. Silliman,	ib.
6.	Saw gate, slides for,	Henry Johnson and Nelson Johnson,	ib.
7.	Granite, &c. cutting, &c.	Mighill Nutting,	ib.
8.	Grass, &c. cutting,	Alexander M. Wilson,	111
9.	Grass, &c. cutting,	Alexander M. Wilson,	ib.
10.	Boats for canals, &c.	Abraham Morrison,	ib.
11.	Boats, propelling,	Jesse Ong,	112
12.	Explosions, to prevent,	Augustus Eitelgeorge	ib.
13.	Water Wheels,	Nehemiah B. Stanton,	113
14.	Rail for rail-ways,	John Ruggles,	ib.
15.	Fire arms, &c.	Henry C. Fay,	ib.
16.	Tub Wheels, applying water to	David B. Napier,	ib.
17.	Stoves,	Ethan A. Andrews,	ib.
18.	Oil cloths, &c. drying,	Daniel Sampson,	114
19.	Cannon, pointing,	John Hobday,	ib.
20.	Cannon, cast-iron,	Cyrus Alger,	ib.
21.	Saddle trees,	William Kelly,	ib.
22.	Rice, hulling, &c,	Charles K. Harvey and Erastus Tracy,	ib.
23.	Stove,	Washington Auld, and Jas Cox,	115
24.	Water wheel,	Joseph C. Green,	ib.

25.	Grain, cleaning, &c.	Markwell Thomas,	115
26.	Friction matches,	Stephen Dale,	116
27.	Locks, &c. for doors,	James McClory,	ib.
28.	Fire arms,	Otis W. Whittier,	ib.
29.	Liquids, drawing of,	Jasper Johnson,	ib.
	June, 1837.		
1.	Railroad cars,	Gustavus Plantou,	173
2.	Loco foco matches, dipping,	John Hatfield,	ib.
3.	Bricks, drying,	James Hodges,	174
4.	Steam boilers,	James J. Rush,	ib.
5.	Trusses,	Heber Chase,	ib.
6.	Boards, planing,	Samuel Whitney,	175
7.	Cotton press	Gideon Fitz,	ib.
8.	Wild peas, &c. separating,	Lester Butler,	ib.
9.	Clapboards, sawing,	Samuel Goss,	ib.
10.	Shingles sawing,	Samuel Goss,	176
11.	Ashes, leaching,	Garret Clement,	ib.
12.	Hides, &c. softening,	Eli Kendall,	ib.
13.	Hat Bodies,	Thomas Blanchard,	ib.
14.	Irons, heating,	Bartholomew W. Taber,	ib.
15.	Timber, preserving,	August Gotthilff,	ib.
16.	Plough,	Bancroft Woodcock,	177
17.	Hemp, &c. breaking,	John Warren,	ib.
18.	Flax, &c. breaking and dressing,	Harvey Lull,	ib.
19.	Stoves, coal,	Aaron O. Price,	ib.
20.	Harness,	Robert Beale,	178
21.	Capstans, for ships, &c.	Increase Wilson and Francis Beckwith,	ib.
22.	Hides, scraping,	Reuben Shailor,	ib.
23.	Caoutchouc,	Charles Goodyear,	ib.
24.	Mop-heads,	Jacob Howe,	179
25.	Dye wood, cutting,	Lucilius H. Mosely,	ib.
26.	Mills for coffee, &c.	Hiram Twiss,	ib.
27.	Skins, extracting hair from,	Edward Flint,	ib.
28.	Fermentation, saccharine, &c.	John J. C. Sheridan,	ib.
29.	Lamps for houses,	Samuel Rust,	180
30.	Mortising timber,	Thomas H. Hoskins,	ib.
31.	Lamps and torches,	Jeremiah Marting,	ib.
32.	Grate,	Roger M. Sherman,	ib.
33.	Dress Cases,	Granville D. Allen,	ib.
34.	Horse power, frame work for,	John A. Nelson and J. P. Ross,	181
	July, 1837.		
1.	Rotary press,	Moses Bayley,	259
2.	Cotton thinning growing,	John Weaver,	ib.
3.	Pistol knife,	George Elgin,	ib.
4.	Axle and box,	William Sheer,	ib.
5.	Cutting garments,	Andrew Wiswell,	260
6.	Tobacco press,	James T. Bowman,	ib.
7.	Spreading lime, &c.	Francis H. Smith,	ib.
8.	Plough,	Samuel Hartpence and John D. Bowne,	ib.
9.	Plough,	John C. Smith,	261
10.	Hatcheling hemp,	Phineas G. and Gabriel Rice,	ib.
11.	Sash fastening,	Philip F. Hazard,	ib.
12.	Maps, colouring,	Lucius Stebbins,	ib.
13.	White Lead,	Charles Ripley,	262
14.	Candles, moulding,	Joseph H. Tuck,	ib.
15.	Serving and worming mallet,	John B. Petival,	ib.
16.	Band wheels, hanging,	Isaac Straub,	263
17.	Steam boilers, rivets for,	Levi Severance,	ib.
18.	Iron ore, carbonating, &c.	Asa Whitney,	ib.
19.	Suspension grate,	Thomas Pearson,	265
20.	Hay, elevating,	George Welbur,	ib.
21.	Floating dry dock,	James Barron,	ib.
22.	Plough,	J. B. Norton,	266

23.	Thread waste,	Ogden Griswold,	26
24.	Horse Power,	Levi Rice and Daniel Cogden,	ib
25.	Horse power,	Levi Rice,	ib
26.	Soap making,	Daniel E. Stillwell,	ib.
27.	Carriages,	Samuel C. Brown and Levi J. Hicks,	268
28.	Valves for Pumps,	Henry Heckman,	ib.
29.	Pegs for boots, &c.	Joseph Ess x,	ib.
30.	Rotary Stoves,	Rensellaer D. Granger	ib.
31.	Tailoring,	Amos Sherman,	269
32.	White paint,	Forrest Shepherd,	ib.
33.	Water-colour paint,	Forrest Shepherd,	ib.
34.	Machinery propelling,	Barnabas Langdon,	270
35.	Sounding instrument,	Francis B. Ogden,	ib.
36.	Grates,	Ellison Conger,	271
37.	Cooking stove,	Abraham T. Mixsell,	ib.
38.	Stove, cooking, &c.	William B. Kimball,	ib.
39.	Temples for looms,	Samuel P. Mason,	272
40.	Stoves, anthracite,	Jordan L. Mott,	ib.
41.	Rail roads,	Isaac Cooper,	ib.
42.	Cars, &c. for rail-roads,	Robert Grant,	ib.
43.	Plough, self-sharpening,	Isaac Snyder,	273
44.	Mouldings, planing,	Ambrose Church,	ib.
45.	Fire arms,	Henry Harrington,	ib.
46.	Salt water, purifying,	Nils Van Schoultz,	274
47.	Spinning wool roving,	Edgar M. Titcomb,	ib.
48.	Horse shoes,	B. Young and S. Titus,	ib.
49.	Thread waste,	William Gray,	321
50.	Cooking stoves,	Edwin Reed,	322
51.	Ovens for stoves,	David W. Barker,	ib.
52.	Locomotive Engines,	Ross Winans,	ib.
53.	Cooking stove, coal,	William Kinney,	ib.
54.	Blowing locomotive fires,	Ross Winans,	ib.
55.	Locomotive engines,	Ross Winans,	323
56.	Cooking stove,	James Richardson,	ib.
57.	Locomotive engines,	Ross Winans,	ib.
58.	Steam boilers, heating water for,	Ross Winans	324
59.	Grate, revolving,	Enos B. M. Hughes,	ib.
60.	Doors, strips for,	Isaac D. Brower,	325
61.	Ice breakers, &c.	Washington Van Dusen,	ib.
62.	Hernia, pads, &c. for,	Robert Thompson,	326
63.	Rotary steam engines,	David Grannis and David E. Brand,	ib.
64.	Shingles, &c. dressing,	George L. Day,	327
65.	Screws, cutting.	Joseph Blackhall,	ib.
66.	Hemp, &c, breaking, &c.	Chapman Warner, A. T. Mixsell and J. E. Horn,	ib.
67.	Checks, printing, &c.	John Dainty,	328
68.	Mouldings, &c. turning, &c.	Eli Coddington,	ib.
69.	Tire of wheels, bending,	Thomas C. Barton,	ib.
70.	Tire of wheels, drilling,	Thomas C. Barton,	ib.
71.	Husking corn,	Jonathan Cutler,	ib.
72.	Door knobs,	David Hoffman,	ib.
73.	Steam boats, wheels for,	William A Douglass,	329
74.	Plough,	John Deats,	ib.
75.	Pistol dirks,	Robert W. Andrews,	ib.
76.	Steam boilers,	Ross Winans,	ib.
77.	Feathers, cleaning, &c.	Samuel Sweet,	330
78.	Removing houses,	Stephen Compton,	ib.
79.	Iron ore, smelting,	Joseph Lyon,	ib.
80.	Stove, cooking, &c.	Rufus S. Payne,	ib.
81.	Seeds, preparing,	James Criswell,	ib.
82.	Stove,	Philip Wilson,	ib.
83.	Skins, removing wool, &c. from,	Benjamin F. Emery,	ib.

84. Water wheels,	Clayton Parker and Robert W. Engle,	331
85. Rail-road frogs,	George S. Griggs,	ib.
86. Crimping leather,	Moses S. Woodward,	ib.
87. Wheels for locomotives,	Elisha Town,	ib.
88. Cooking stove,	John Collins,	ib.
July, 1837.		
1. Spreading plasters,	B. Morrison,	385
2. Steam engine,	Ashur Miller,	ib.
3. Fires, applying warm air to,	John Silsbee,	386
4. Gum senegal, factitious,	Walter Leversidge,	ib.
5. Shingle machine,	Enoch R. Morrison,	ib.
6. Grate,	Edward H. Dixon,	387
7. Handkerchief loom,	Enoch Burt,	ib.
8. Stoves,	Samuel Utter,	ib.
9. Napping cloth,	Benjamin Swazey,	ib.
10. Stoves,	James Wilson,	388
11. Doubling and twisting,	John Golding,	ib.
12. Safes,	Daniel Fitzgerald,	ib.
13. Smut mill,	Charles D. Childs,	ib.
14. Cheese press,	Sullivan White,	389
15. Shingle machine,	Joseph S. Raymond,	ib.
16. Water cisterns,	George W. Blenis,	ib.
17. Cement, resinous,	Thomas Coyle,	ib.
18. Milk pails,	Isaiah Bunnel,	390
19. Paddle wheels,	John S. Greenough,	ib.
20. Saddles, springs,	Jonathan Keedy,	ib.
21. Grappling irons,	E. and T. J. Lobdell,	391
22. Wind mills,	Ebenezer P. Sperry,	ib.
23. Fire arms,	Silas Day,	392
24. Ship building,	Samuel E. Howell,	ib.
25. Quadrant Hinge,	Ebenezer Barrows,	ib.
26. Ox yoke,	Gideon Hotchkiss,	ib.
27. Steam engine packing,	John Williamson,	393
28. Hay press,	Jacob Grosvenor,	ib.
29. Cooking stove,	J. S. Leavitt,	ib.
30. Water cement,	Ebenezer C. Warner,	394
31. Seed disseminator,	Levi Rice,	ib.
32. Smut machine,	Benjamin M. Smith,	ib.

A.

Absorption of gases by water, 168
Acid, nitric, action of on metals, 69
——— new organic, 138
Affinity for water, of the fluids of living, organized structures, 62
Africa, expedition into the interior of, 351
Air-pump for steam engines, Silliman's *patent*, 117
Air, cold, action of, in maintaining heat, 135
Air, friction of the, 193
Alexander's electric telegraph, 188
Alloy in imitation of Gold, 197
Amber, origin of, 70
Analyses of soils near Puiseaux, 340
——— ——— from Cuba, 341
Analysis of sulphate of iron of Nordhausen, ib.
——— of a substance used in colouring porcelain, 342
——— double phosphate of lead and lime, 343
Anthracite coal, smelting iron with, *patent*, 405
——— coal on smelting of iron with, 126
——— advantages of in hot blast furnace, 131
——— notes on smelting iron by means of, 166
——— and clay—smelting iron with, *patent*, 333
Arsenic discovered in a body three years after interment, 195
Ashes, leaching, Clement's *patent*, 182
Asphaltic mastic, 411
Atmospherical phenomena, 68

Athens, present state of, ... 214

B.

Basanite, use of, in hydraulic cement, *patent*, . . . 396
Battery, galvanic, powerful and economical, ... 192
Bell glasses, new substitute for, ... 199
BIBLIOGRAPHICAL NOTICES.
Report on Trusses for Hernia, ... 95
Beeswax, substitute for, *patent*, ... 397
Birmingham—steam engines in, ... 359
Black, platina, ... 64
Blast furnace, Barker's *patent*, ... 54
—— iron, hot, ... 61
Boat, canal, Morrison's *patent*, ... 118
Boilers, steam, water gauge for, ... 94
—— steam engine, Rush's *patent*, ... 181
Bones, fossil, ... 339
Borax lagoons of Tuscany, description of, ... 346
British enterprize abroad, ... 431
Browning gun barrels, ... 194
Brussels and Paris railway, ... 71
Bubbles, permanent soap, ... 65
Buildings, improvement in beams for, ... 416

C,

Caissoon, temporary, for excluding water, ... 59
Canal boat, Morison's *patent*, ... 118
Candles, manufacturing, *patent*, ... 399
Cans, oil, for engineers, ... 94
Caoutchouc, manufacture of, Goodyear's *patent*, . . . 186
—— East India, ... 286
Carbonate of magnesia of Southern India, ... 340
Casks, and cisterns, preserving water in, ... 200
Cataract, on the cause, prevention and cure of, ... 416
Cement and mortar, hydraulic, . . . 1, 73, 145, 217, 289, 361
—— Hydraulic, use of Basanite in, *patent*, . . . 396
Chase, on the cure of Hernia, ... 95
Chisels, Smith's everpointed stone-cutting 430
Chloride of calcium, luminous properties of, ... 66
Chrome, bichromate of the perchloride of, ... 406
Circular cut 143
Climate, effects of cultivation upon 422
Coal in France, ... 214
—— origin of 287
Coal fields in Derbyshire and Yorkshire, ... 213
College, Girard, description of, ... 354
Conductors, efficacy of lightning, ... 409
Cooling and evaporating fluids, Brandt's *patent*, . . . 125
Cop, securing, on power loom shuttles,—Thorp's *patent*, . 51
Corrosion of iron by salt water, ... 69
Courtois on lime and mortar, ... 361
Cuba railway, ... 286

D.

Diamond, vegetable origin of, ... 215
Drag, wagon steam, ... 71
Draper, on simultaneous meteorological observations, . . . 39
Dyeing, improvements in, *patent*, ... 402

E.

Earth, increase of temperature in the interior of the . . . 427
Easy method of preparing platina black, ... 64
Eclipse, solar, reduction of observations of 37
Editor, on electro magnetic machinery, ... 35
Editor's remarks on patents for April, 1837, ... 41
—— —— —— —— —— May, ... 108
—— —— —— —— —— June, ... 173

Editor's remarks on patents for July, . . . 259, 321
——————————— Aug. 385
Electro magnetic propelling machinery, ... 35
——— - magnet—Rev. N. J. Collan's, ... 57
——— magnetic telegraph, report on, . . . 106
Electric telegraph, Alexander's, ... 188
Electrical induction, Prof. Faraday, on 418
——— experiments, ... 190
Ellet, Prof. on new mode to obtain metallic osmium, . . . 384
England—post office, revenue of, ... 359
Evaporating and cooling fluids, Brandt's *patent*, . . . 125
Experiment, new, ... 410
Explosions, in steam boilers not caused by hydrogen, . . . 129

EXTRACTS FROM FRENCH JOURNALS.

Discovery of arsenic in a human body, three years after interment, 195
Alloy in imitation of gold, ... 197
Steatite, various uses of, ... ib.
Panoramas, construction of, ... 198
Potatoes, machine for washing, . . . 199
Bell glasses, new substitute for, ... ib.
Preserving apartments from the odours of a kitchen, . ib.
Water, preserving it in casks and cisterns, . . . 200
Jelly for the sick, ... ib.
Light obtained from the compression of air, . . . ib.
Magnesian hydraulic lime, ... 338
Fossil Bones, ... 339
Carbonate of magnesia of Southern India, . . . 340
Analyses of vegetable soils near Peuiseux, . . ib.
——————————— from Cuba, ... 341
——— sulphate of iron of Nordhausen, . . . ib.
——— substance used in colouring porcelain, . . 342
——— double phosphate of lead and lime, . . 343

F.

Flax and hemp, breaking, &c. Lull's *patent*, . . . 184
Flint in wheat, ... 432
Fluids of living organized structures, affinity of, for water . . 62
——— evaporating and cooling, Brandt's *patent*, . . . 125
Fossil Bones, ... 339
Fox, R. W. on origin of mineral veins, . . . 251
Friction of the air, ... 193
Fucus, floating, near the Cape de Verds, . . . 354
Furnace, blast, Barker's *patent*, ... 54
Furnaces, smelting, Broadmeadow's *patent*, . . . 56
Furnace, hot blast, anthracite in, ... 131
Fuse, miners' safety, ... 63

FRANKLIN INSTITUTE.

Conversation meeting, notice of, ... 41
Fourteenth annual meeting, minutes of, . . . 103
——————————— report, ... 104
Meeting of Board of Managers, minutes of, . . . 172

Committee on Science and the Arts.

Report on Morse's electro magnetic telegraph, . . . 106
——— Telegraphs for the United States, . . . 254

G.

Galvanic telegraph, ... 143
——— battery, economical and powerful, . . . 192
——— shock multiplier, ... ib.
Galvanometer thermoscope, description of a, . . . 343
Garnet, three specimens of, ... 253
Gases, absorption of by water, ... 168
Gauge, rain, ... 64
——— water, for steam boilers, ... 94

Geology of Bretagne, 352
Girard college—description of the, 354
Glaciers, mechanism of the motion of, 353
Glass, mica as a substitute for, 133
——making, sand for, 134
Gold, alloy in imitation of, 197
—— mines, Russian 428
—— new process for extracting, 429
Goode, on the absortion of gases by water, 168
Gradients, mechanical effects of, on Railroads, 414
Griscom's translations from French Journals, 64, 195, 338
——— experiment's on use of Olmsted's stove, 248
Gum senegal, substitute for, *patent*, 394
Gun barrels, browning, 194

H.

Hail, the formation of, 201, 280
Hair, removing—softening skins, &c., *patent*, 334
Heat, action of cold air in maintaining, 135
Heating irons, stove for, Taber's *patent*, 183
Hemp and flax, breaking &c —Lull's *patent*, 184
Hernia, report on trusses for the cure of, 95
Hot Blast iron, 61
———Furnace, advantages of anthracite in, 131
Howell, B. B. notes on smelting of iron by anthracite, 166
Hydraulic cement, use of Basanite in, *patent*, 396
——— cements and mortars, 1, 173, 145, 217, 289, 361
——— lime—magnesian, 338
——— telegraph, 348
Hydrogen gas not the cause of explosions in steam boilers, 129

I.

Incombustible thatch, 348
India rubber, manufacture of, Goodyear's *patent*, 186
Induction, electrical, Prof. Faraday, on 418
Iron, 432
—— smelting with anthracite coal, *patent*, 405
—— hot blast, 61
—— corrosion of by salt water, 69
—— sulphate of—of Nordhausen, analysis of, 341
—— smelting with anthracite, 126
———————— notes on, 166
———————— and clay, 333
Iron rails for rail-ways, 211
—— steam vessels, 155
Irons, stove for heating, Taber's *patent*, 183

J.

Jamaica, minerals in, 287
Jelly for the sick, 200
Jones, A. C. on oil cans for engineers, 94
——— —— water gauge for steam boilers, ib.

K.

Kendall's reduction of observations of solar eclipse, 37
Kitchen, preserving apartments from the odours of, 199

L.

Lagoons, borax, of Tuscany, description of, 346
Lancashire, manufactures of 432
Leaching ashes, Clement's *patent*, 182
Lead and lime, double phosphate of, 343
Leather ornaments 285
Lightning conductors, efficiency of, 409
Light, atmospherical phenomena of reflected, 68
—— obtained by the compression of air, 200
Lime-burning, researches on, by M. Petot, 289
—— magnesian hydraulic, 338
—— and mortar, researches as to, by M. Courtois, 361

Locomotive engines, Harrison's *patent* . . . 122
Loom shuttles, power, holding cop on, Thorp's *patent*, . . . 51
Luminous properties of chloride of calcium, . . . 60
Lunar occulations, . . . 72, 144, 216, 288, 360, 432

M.

Magnesia—carbonate of, of Southern India, . . . 340
Magnesian hydraulic lime, by M. Vicat, . . . 338
Magnetic, electro, propelling machinery, Editor on . . . 35
Magnet, electro—Rev. N. J. Callan's, . . . 37
Manufactures of Lancashire, . . . 432
Manuscripts, Sir Isaac Newton's, . . . 70
Mastic, Asphaltic, . . . 411
Medal striking, . . . 141
Metallic osmium, new mode of obtaining, . . . 384
——— sheathing for vessels, *patent*, . . . 395
Metals, action of nitric acid on, . . . 69
Meteorological observations, . . . 72, 144, 216, 288, 360
——————— simultaneous, . . . 39, 425
Mica, as a substitute for glass, . . . 133
Mines, Russian gold . . . 428
Miners' safety fuse, . . . 63
Mineral veins, origin of, . . . 251
Minerals in Jamaica, . . . 287
Mortars, hydraulic and common, . . . 1, 73, 145, 217, 289, 361
Mould—vegetable, formation of, . . . 349

N.

Newton's Manuscripts, . . . 70
Nitric acid, action of on metals, . . . 69

O.

Occulations, lunar, . . . 72, 144, 216, 288, 360, 432
Odours of a kitchen, preserving apartments from, . . . 199
Oil cans for engineers, . . . 94
— cloths, drying, Sampson's *patent*, . . . 121
— heating seeds for pressing, *patent*, . . . 334
Olmsted's stove, experiments on the use of, . . . 248
Organic acid, new, . . . 138
Osmium, metallic, new mode of obtaining, . . . 384

P.

Paddle wheel, Hull's *patent*, . . . 124
Paint, white, Shepherd's *patent*, . . . 274
——— water colour, Shepherd's *patent*, . . . 275
Panoramas, construction of, . . . 198
Paris and Brussels rail way, . . . 71
Parsons on the mechanical power of the pulley, . . . 245
Patents, American, list of with remarks, . . . 41, 108, 173, 259, 321, 385
Paving streets with wood, . . . 357
Petot, M —researches on lime, burning, . . . 289
Phosphate, double, of lead and lime, . . . 343
Physiolgy, vegetable, . . . 136
Platina, black, . . . 64
Porcelain—analysis of a substance used in colouring . . . 342
Post office revenue, of England, . . . 359
Potash, preparation of bicarbonate of, . . . 408
Potashes, leaching ashes for manufacturing, Clement's *patent*, . . . 182
Potatoes, machine for washing, . . . 199
Power loom shuttles, holding cop on, Thorp's *patent*, . . . 51
Press, stamping, Barns's *patent*, . . . 52
Public buildings, defacing, . . . 415
Pulley, mechanical power of, . . . 245
——— ——————— observations on, . . . 384

R.

Rail for rail-ways, Ruggles' *patent*, . . . 119
Railroad, mechanical effects of gradients on, . . . 414
Rail-roads, constructing, Cooper's *patent*, . . . 276
Rails, iron, for rail-ways, . . . 211

Rail-way, Paris and Brussels, ... 71
Rail-way stock at Liverpool, ... 143
Railway speculations, ... 415
—— way, Cuba, ... 286
Rail-ways in America, and Germany, form of, ... 140
——— of continuous bearing 140
Rain gauge, ... 64
River—subterranean, discovery of, ... 353
Rubies, artificial production of, ... 138

S.

Saddle trees—Kelly's *patent*, ... 121
Salt water, purifying—Van Schoultz's *patent*, ... 278
——— corrosion of iron by 69
Sand, for glass making 134
Seeds, heating, for pressing—*patent*, ... 334
Sheating, metallic, for vessels—*patent*, ... 395
Shooting stars, ... 209
Shuttles, power loom, securing cop on—Thorp's *patent*, . . . 51
Skins, softening and removing hair—*patent*, ... 334
Smelting furnaces—Broadmeadow's *patent*, ... 56
——— iron with anthracite, ... 126
——— ——— ——— coal—*patent*, ... 405
——————————— notes on 166
——————————— and clay—*patent*, ... 333
Soap bubbles, permanent 65
Soda, sulphate of, application of, in dyeing—*patent*, . . . 402
—— carbonate of, manufacture of—*patent*, ... 403
Soils, analyses of vegetable, near Puiseaux, ... 340
——————————— from Cuba, ... 341
Solar eclipse, reduction of observations of 37
Spark, thermo-electric 71
Sphere, method of forming a true 347

SPECIFICATIONS OF PATENTS.

Hold the cop on power loom shuttles—Thorp's, ... 51
Standing press—Barns' 52
Blast-furnace—Barker's 54
Smelting furnace—Broadmeadow's 56
Air-pump for low pressure engines—Silliman's 117
Canal boats—Morrison's 118
Rail, for railways—Ruggles' 119
Drying oil-cloths—Sampson's 121
Saddle trees—Kelly's . . . . . ib.
Improvements in locomotive engines—Harrison's . . . 122
Paddle wheel—Hall's 124
Cooling and evaporating fluids—Brandt's 125
Steam engine boilers—Rush's 181
Leaching ashes—Clement's 182
Stove for heating irons—Taber's 183
Protecting timber—Gotthilff's . . . . . ib.
Breaking and dressing hemp, &c.—Lull's 184
Caoutchouc, manufacture of—Goodyear's 186
White paint—Shepherd's 274
Water colour paint—Shepherd's 275
Rail-roads—Cooper's 276
Salt water, purifying—Nils Sholtewskii Van Schoultz's . . 278
Heating water for steam boilers—Winan's 332
Smelting iron with anthracite and clay—Lyon's . . . 333
Heating seeds for pressing—Criswell's 334
Softening skins and removing hair—Emery's . . . ib.
Wheels for ascending inclined planes—Town's . . . 336
Manufacturing white lead—Holland's . . . . . ib.
Substitute for gum senegal—Leversidge's 394
Metallic sheathing of vessels—Robinson's 395
Hydraulic cement—Warner's 396